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DRAFT REPORT
of the
Surface Impoundments Study Subcommittee
of the Science Advisory Board's
Environmental Engineering Committee
for discussion at public meeting
October 24-26, 2001

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460**

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OFFICE OF
THE ADMINISTRATOR
EPA SCIENCE ADVISORY BOARD

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The attached draft report is a draft report of the EPA Science Advisory Board (SAB). The draft is still undergoing internal SAB review, however, in its present form, it attempts to present the preliminary consensus position of the panel to the charge questions for the review. After the Subcommittee has approved its report, it will be considered by the Environmental Engineering Committee and then the Executive Committee. Once approved as final, the report will be transmitted to the EPA Administrator and will become available to the interested public as a final report.

This draft has been released for general information to members of the interested public and to EPA staff. This is consistent with the SAB policy of releasing draft materials when the document is sufficiently complete to provide useful information to the reader. The reader should remember that this is an unapproved working draft and that the document should not be used to represent official EPA or SAB views or advice. Draft documents at this stage of the process often undergo significant revisions before the final version is approved and published.

The SAB is not soliciting comments on the advice contained herein. However, comments on the issues listed below could be helpful.

1. Has the Committee adequately responded to the questions posed in the Charge?
2. Are any statements or responses made in the draft unclear?
3. Are there any technical errors?

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2. INTRODUCTION

This chapter of the report provides the background, context, charge for the review and the procedural history. Specific responses to charge questions can be found in Chapter 3 while findings and recommendations on issues beyond the charge are presented in Chapter 4.

2.1 Background

2.1.1 What are Surface Impoundments?

Essentially, surface impoundments are artificial ponds which contain waste-water of one sort or another. In the United States there are thought to be 30,000 surface impoundments or more containing wastewater from agriculture, industry or mining or storm water. About 18,000 of these impoundments are industrial surface impoundments. OSW estimates that about two-thirds of these have high pH, low pH, or chemicals of concern.

Industrial impoundments vary greatly in size, from less than a quarter of a hectare (1/3 of an acre) to several hundred hectares. The larger impoundments provide the bulk of the total national industrial impoundment capacity.

In the United States, industrial surface impoundments are an important and widely used industrial materials management unit. Surface impoundments serve a variety of beneficial uses in a number of industrial processes. Industrial facilities that produce waste-waters often use surface impoundments to perform necessary wastewater treatment prior to discharge into surface waters. In other cases, industrial facilities may need to control wastewater flows and use surface impoundments for storing excess wastewater. In still other cases, industrial facilities may use surface impoundments to manage their excess waste-waters through evaporation or seepage into the ground.

Industrial impoundments frequently use management techniques that increase the potential for chemical releases and frequently are found in environmental settings that increase the potential for impacts to humans or ecosystems in the event of a chemical release. In this study, EPA found that most industrial impoundments are located only a few meters above groundwater and that, in most cases, shallow groundwater discharges to a nearby surface waterbody. More than half of the impoundments do not have liner systems to prevent the release of wastes to soil or groundwater. In addition, about 20 percent of impoundments are located within 150 meters of a fishable waterbody, so migration through the subsurface to the nearby surface water is possible. Finally, while aeration can have certain benefits, it also increases volatilization and the potential for airborne

contaminant migration. EPA found that about 45 percent of the total wastewater quantity managed in impoundments is aerated.

2.1.2 What Kinds of Wastes are Stored in Industrial Surface Impoundments?

Waste-waters which are neither “characteristic” or “listed” hazardous wastes under RCRA may be found in industrial surface impoundments.¹ In the SIS, EPA requested information on the presence and quantities of 256 chemical constituents of concern in the impoundments. More than half of the impoundments with chemical constituents or pH of concern are in the chemical, concrete, paper, and petroleum industries. On a volume basis, the paper and allied products sector manages roughly two-thirds of the total quantity of wastewater, more waste in impoundments than all of the other industry categories combined.

2.1.3 What did Legislation and the Consent Decree Require?

The Resource Conservation and Recovery Act, or RCRA, provides a “cradle to grave” regulatory scheme for hazardous wastes. 1984 amendments to RCRA required that EPA restrict the practice of placing hazardous wastes in land-based waste management units. A June 1, 1990 regulation implemented this restriction for “characteristic” hazardous wastes that are managed in wastewater systems. In that regulation, EPA interpreted the 1984 amendments to allow land placement of wastes that were formerly characteristic hazardous wastes, and were managed in wastewater systems, but that had been treated or diluted so that the characteristic hazard was removed. For simplicity, EPA refers to these wastes as “decharacterized” wastes, meaning the characteristic hazard has been removed, and they are no longer characteristic hazardous wastes. EPA was sued by Chemical Waste Management, Inc. over this interpretation. The court’s opinion was that RCRA required EPA to set treatment standards that minimize threats to human health and the environment.²

To comply with the court’s opinion, EPA promulgated a 1996 final regulation that in certain cases imposed treatment requirements before, during or after their placement in surface impoundments. Soon after the regulation was signed, Congress enacted the Land

¹The RCRA regulatory scheme delineates “characteristic” hazardous wastes as one type of hazardous waste; the other type is known as “listed” hazardous wastes. Characteristic hazardous wastes exhibit one or more of four separate hazardous properties: corrosivity, ignitability, reactivity, or toxicity.

²The specific issue in the case was the continued presence of ‘underlying hazardous constituents’ in the waste, even after the characteristic hazard was removed.

1 Disposal Program Flexibility Act of 1996, or LDPFA, which effectively rescinded the 1996
2 rule (but kept the treatment requirements in effect in limited circumstances).

3 In addition to these developments, in 1989, the Environmental Defense Fund
4 (EDF) sued the U.S. Environmental Protection Agency (EPA), in part, for failing to meet
5 the statutory deadlines of Section 3001(e)(2) of the Resource Conservation and Recovery
6 Act (RCRA; *EDF vs. Whitman*; Civ.No. 89-0598 D.D.C.). To resolve most of the issues in
7 the case, EDF and EPA entered into a consent decree which sets out an extensive series
8 of deadlines for promulgating RCRA rules and for completing certain studies and reports.
9 A 1997 amendment to the consent decree required EPA to study human health risks from
10 air inhalation of 105 chemical constituents present in surface impoundments. In the
11 consent decree requirement, the waste in the impoundment is classified as nonhazardous
12 under the federal RCRA regulations, but is also not the decharacterized waste at issue in
13 the preceding two paragraphs. Together, the two provisions - the legislation and the
14 consent decree - called on EPA to conduct a study of the risks associated with all
15 nonhazardous waste surface impoundments.

16 Currently any ultimate discharge from industrial surface impoundments is subject to
17 regulation under the Clean Water Act (CWA)

18 **2.1.4 What was OSW's Surface Impoundments Study?**

19 EPA estimates that, in the 1990s, there were approximately 18,000 industrial
20 surface impoundments in use throughout the United States. These surface impoundments
21 were present at about 7,500 facilities located primarily east of the Mississippi River and in
22 Pacific Coast states. Because of the scope of the universe, EPA conducted the study
23 focusing on a sample of U.S. facilities that use impoundments to manage industrial
24 nonhazardous waste.

25 Most of the facilities selected for the study were chosen randomly to ensure that the
26 sample facilities would be representative of the facilities in the study population. EPA sent
27 surveys to 221 facilities to collect information on their impoundments and the wastes
28 managed in them. EPA requested information on the presence and quantities of
29 256 chemical constituents of concern in the impoundments, as well as on the
30 impoundments' design and operation. EPA used these data to characterize the potential
31 risks that may be posed by managing the wastes in impoundments. The survey responses
32 on the presence and concentrations of specific chemical constituents were particularly
33 central to EPA's analysis. EPA also collected and analyzed wastewater and sludge from
34 impoundments at 12 facilities in the study and used that information to illuminate the
35 completeness and accuracy of the survey data. EPA also used data from a variety of other
36 sources such as facility permit files, U.S. Census data, and technical references.

OSW's report, Industrial Surface Impoundments in the United States, discusses risks to human health and the environment that may be posed by managing industrial nonhazardous wastes in surface impoundments. It provides 1) estimates of cancer and non-cancer human health risks for individuals, or "receptors," who may be exposed to releases from surface impoundments used to manage wastewaters and wastewater treatment sludges, 2) a screening analysis of other indirect pathway human health risks, and 3) a screening analysis of the potential risks to ecological receptors.

2.2 Context

EPA will use the risk results, along with the analysis of existing regulatory and nonregulatory programs designed to address the risks (described in Chapter 4 of the report) to decide whether, and if so, how, to apply the land disposal restrictions or take other appropriate actions to address risks found.

2.3 Charge

The Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) is requested to review the Industrial Surface Impoundments in the United States report, its appendices, and attachments to the appendices, dated March 2001, along with other relevant materials. Although any comments on the report are appreciated, EPA developed the following general and specific questions for the SAB:

1. Overall

This study was a classic risk assessment for use in reviewing waste management practices at nonhazardous waste surface impoundments. It relied on primary data collected for the specific purpose of answering the study questions. The study's technical objective was to assess risks posed by the waste management practices described in the statute and consent decree. The study population consisted of facilities with three different types of Clean Water Act regulatory status: direct, zero, and indirect dischargers.³ For direct and zero dischargers, the study design was a randomized two-phase sample of facilities, with all eligible impoundments selected at the second-phase sample facilities. We used a questionnaire to collect basic information regarding each facility and surface impoundment in the second-phase sample. We also collected publicly available data and conducted a limited field sampling effort at some facilities. These data were used to

³The legislation specified these three Clean Water Act categories, and thus defined the study population.

1 develop a risk analysis to evaluate the nature and extent of human health and ecological
2 impacts posed by these surface impoundments.⁴

3 The policy questions posed in the legislation and the consent decree were:
4 “to characterize the risks to human health or the environment associated with [managing
5 decharacterized wastes in Clean Water Act treatment systems]” and to “evaluate the extent
6 to which risks are adequately addressed under existing State or Federal programs and
7 whether unaddressed risks could be better addressed under such laws or programs.”
8 (RCRA section 3004(g)(10))

9 and

10 The Administrator shall...perform [a] stud[y] on gaps in the hazardous waste
11 characteristics and relevant Clean Air Act ("CAA") controls, and the resulting potential
12 risks to human health, posed by the inhalation of gaseous and non-gaseous air emissions
13 from wastes managed in...surface impoundments (excluding those impoundments
14 receiving decharacterized wastewaters that the Agency is obliged to study pursuant to
15 section 3004(g)(10) of RCRA, 42 U.S.C. S 6924(g)(10))....⁵

16 In offering an overall review of the study EPA asks the reviewers to keep these
17 general questions in mind:

- 18 a) Does the Science Advisory Board believe that the general methodology we
19 chose for developing our risk analysis was appropriate for the policy
20 questions posed in the statute and consent decree?
- 21 b) Regarding the overall study implementation, from design through sample
22 selection, data collection and analysis, what areas of strength do you see in
23 the overall methodology, and what areas of potential improvement or
24 additional analysis do you recommend?
- 25 c) Did EPA adequately characterize the risks? Are the risk analysis and
26 findings transparent? That is, are they explicit in:
- 27 describing the assessment approach, assumptions, extrapolations
28 and use of models

⁴For indirect dischargers, the design was a purposive sample, with all eligible impoundments selected at the sampled facilities, collection of primary survey data, analysis of those survey data, and comparison with direct and zero discharger results.

⁵Civ. No. 89-0958, *Environmental Defense Fund, Inc. vs. Whitman et al.* June 12, 1997.

1 describing plausible alternative assumptions

2 identifying data gaps

3
4 distinguishing science from policy

5
6 describing uncertainty, and

7 describing the relative strength of the assessment?

- 8 d) Please provide your assessment of the accuracy of EPA's overall study
9 conclusions regarding risks to human health and the environment. Were the
10 conclusions either false positive or false negative conclusions (finding risks
11 of greater or lesser magnitude than the risks that likely exist)?

12 **2. Abnormal Operating Conditions**

13 Regarding the releases that result from abnormal operating conditions, such as
14 overtopping, or dike/berm failures, we asked survey respondents about the frequency,
15 duration and magnitude of these kinds of events.⁶ We presented the findings in Chapter 2,
16 page 2-26, but did not attempt to incorporate this information into the risk assessment or
17 otherwise perform failure modeling, due to concerns about the high non-response rate on
18 this particular survey question, as well as possible memory effects (recall and reporting of
19 more recent events).

- 20 a) In light of the findings of the report, should EPA perform a more detailed
21 evaluation of abnormal operating events, would the data collected point to
22 additional studies or research to provide more detail about this issue? If so,
23 what methods or approaches would the SAB recommend regarding
24 collecting more reliable data, and modeling the probability and impacts of
25 such events?

26 **3. Screening-level risk characterizations**

27 For most pathways of potential concern, EPA conducted conventional risk
28 assessments using well-developed and peer reviewed modeling tools. These analyses
29 resulted in formal estimates of risks or exceedances of health thresholds and were
30 conducted for the direct ingestion of groundwater, direct inhalation and the examination of
31 groundwater to surface water impacts on human health ambient water criteria.

⁶See Attachment A-1, Survey of Surface Impoundments question C25.

1 For a variety of potential indirect exposures to human receptors, EPA conducted a
2 screening level risk characterization. These included potential exposures through indirect
3 pathways such as ingestion of crops, dairy products and fish that might be contaminated
4 through a variety of transport mechanisms such as runoff from closed impoundments, or air
5 dispersion onto nearby farmlands. This analysis consisted of a categorizing and ranking
6 of exposure factors of potential concern for each facility in order to identify facilities where
7 indirect pathways may be of potential concern, rather than a formal risk assessment.⁷

8 Similarly, EPA conducted a screening level risk characterization of potential
9 ecological concerns. This assessment identified facilities where there could be ecological
10 concerns provided there were direct contact and ingestion of surface impoundment
11 contents by various ecological receptors, using conservative screening assumptions.⁸

12 The reasons we conducted screening level risk characterizations for indirect
13 pathways and for potential ecological risks were that the available data and available
14 modeling tools were less complete and less certain, and we wanted to present results in a
15 manner commensurate with the level of certainty in the available data.

- 16 a) For the indirect human health and ecological screening-level analyses, in the
17 SAB's view, do the results point to areas of potential future research? If so,
18 do you have recommendations on prioritizing future studies in these areas?
- 19 b) Based on the screening-level estimates we developed for other indirect and
20 ecological risks, did it appear that we overlooked potential problem areas?
- 21 c) Did we clearly describe and properly characterize the other indirect human
22 health and ecological risk analyses?

23 **4. Survey Data on Chemical Constituent Presence/Quantity**

24 EPA used various data processing and analysis protocols to ensure consistency in
25 interpreting survey data on a specific constituent's presence in an impoundment, or that
26 constituent's quantity. EPA used analysis methods and presentation techniques to help
27 distinguish and explain the various degrees of certainty in the findings. Please comment
28 on the appropriateness of the application of these data processing and analysis protocols,

⁷EPA's methodology and results for describing the human health risks potentially posed by indirect pathways, other than the groundwater to surface water pathway, is described in the report in section 3.4 and Appendix C, beginning on page C-135.

⁸The methodology and results for describing the potential ecological risks is described in the report in section 3.5 and Appendix C, beginning on page C-159.

1 and on the degree of clarity of the risk results presentation, in the situations described
2 below.

3 Surrogate data.⁹ In this situation, the survey respondent clearly indicated the
4 presence of a particular chemical constituent in an impoundment, but did not indicate a
5 corresponding quantity. EPA used the surrogate data protocol described in Appendix A to
6 impute a value according to a specific hierarchy of assumptions. In the risk results, EPA
7 presented findings of risks that were computed based on these surrogate values
8 separately from findings of risks above the relevant threshold level that were computed
9 based on reported survey values for chemical constituent quantities.

10 a) Is it likely that EPA's data imputation protocol, or "surrogate data protocol"
11 for imputing waste composition data markedly affected the ultimate
12 conclusions regarding potential risks? If so, in what direction did the
13 protocol probably bias the conclusions?

14 b) Should EPA have used any other approaches for qualifying or presenting the
15 data?

16 Detection limits.¹⁰ There were various situations in which the specific chemical
17 constituents were clearly indicated, but the quantities were unknown because the only
18 information reported was that the chemical was not detected in a laboratory analysis. In
19 the first such situation, the survey respondents provided the pertinent detection limits, and
20 EPA's data processing and analysis protocols called for using the reported detection limit
21 as the actual quantity present in the impoundment, for the purpose of performing the
22 screening or risk assessment. In the second situation, the survey respondents provided
23 the chemical's identity and some kind of indication that the chemical was present below
24 some sort of detection limit, but the exact detection limit was not stated. Typically, the
25 survey response included "ND" or "BDL" which EPA interpreted as "nondetect" or "below
26 detection limit." In this second situation, the data processing and analysis protocols called
27 for using an EPA-generated default detection limit for the chemical constituent in question,
28 and assuming that the constituent was present at that detection limit. In either of these
29 situations, EPA kept findings of risks above the relevant threshold level that were
30 computed based on these detection limit values separate from findings of risks above the
31 relevant threshold level that were computed based on reported survey values for chemical
32 constituent quantities.

⁹See pages A-36 to A-38 of Appendix A, Study Design and Survey Data Collection and Processing.

¹⁰See pages A-35 and A-36 of Appendix A, Study Design and Survey Data Collection and Processing.

- c) Was using the assumption that a chemical could be present up to the detection limit, when it was reported as being present below a detection limit, a reasonable concentration to choose for risk screening purposes? Was this assumption reasonable in cases where the constituent was not expected to be present at the facility?
- d) Did the EPA-generated default detection limit protocol provide reasonable approximations of likely detection limits encountered in the field by the facilities, when the detection limits were not reported in the laboratory analysis?
- e) Do the results that are based on imputed/detection limit data suggest that further analysis is needed?

5. Analysis and implications of field sampling data.

Based on a comparison of the EPA field sampling results with the corresponding reported survey values for chemical concentrations/quantities, EPA concluded that the survey respondents generally did not systematically under report the quantities of chemical constituents present in the impoundments.¹¹

- a) Although there are limitations of performing the comparison of survey and field sampling waste composition data, what is the SAB's view on EPA's conclusions about the accuracy of the reported survey data on chemical constituent concentrations/quantities?

Based on a comparison of the EPA field sampling results with the corresponding reported survey information on chemical constituents present in the impoundments, EPA concluded that there may have been incomplete reporting of the entire suite of chemical constituents present in the impoundments.¹²

- b) What is the SAB's view on EPA's conclusion on the potential incomplete reporting of chemical constituents present?

¹¹See Attachment E-1 for a table showing the reported survey values and corresponding field sampling measurement results.

¹²See Attachment E-2 for a table listing the facilities, impoundments and chemical constituents found in the field sampling but not reported on the survey.

- 1 c) Would the SAB recommend alternate approaches, in order to obtain the
2 best possible information regarding the exact chemical constituents present,
3 given the same budget and time constraints?

4 **6. Groundwater source term.**

5 In order to estimate potential risks posed by the groundwater and the groundwater
6 to surface water pathways, EPA needed to represent the impoundment and its contents in
7 a modeled system, in which the contaminants that enter the groundwater transport pathway
8 are represented as a mass flux of contaminants from the impoundment into the
9 groundwater system. This mass flux is the groundwater source term, and EPA needed
10 data on the identity and quantity of chemical constituents entering the groundwater system
11 in order to model it properly.

12 The survey requested data on chemical constituents and their quantities in leachate
13 from the impoundments. Leachate is the portion of the waste that is managed in a waste
14 management unit, but leaks ("leaches") out of the bottom or sides of a land-based waste
15 management unit. Facilities that collect leachate from their impoundments were able to
16 report on chemical constituent presence/quantities in leachate, but relatively few facilities
17 in the study sample appear to collect their impoundments' leachate. Thus, relatively few
18 facilities answered the questions on leachate composition. However, virtually all the
19 facilities that supplied waste composition data at all supplied it for wastewater
20 composition.

21 To perform the data analysis, EPA needed to take a step-wise, efficient approach,
22 beginning with screening thousands of impoundment/chemical combinations and ultimately
23 modeling some. For these purposes EPA used the wastewater concentration. In
24 impoundments in which little or no sludge is present, using wastewater composition data
25 would be a reasonable approximation for the mass flux into groundwater. However, in
26 impoundments in which some amount of sludge is present, it is reasonable to expect that
27 for some chemical constituents, the concentrations of those constituents present in the
28 pore water of the sludge could be considerably different than the concentrations present in
29 the impoundment wastewater, and would be more similar to the leachate composition than
30 would the wastewater composition. Reviewing some of the field sampling data on
31 sludges, compared to the corresponding wastewater composition, indicates that the
32 decision to use wastewater concentration may have underestimated the contaminant mass
33 by more than an order of magnitude, for certain chemical constituents.

- 34 a) Would the SAB recommend another approach for representing the
35 groundwater source term, for example, performing a bounding analysis,
36 using the sludge data, where available, to represent an upper bound of the

groundwater source term, and using wastewater data as the lower bound, for those chemical constituents for which this situation may be an issue?

- b) Compared to other sources of uncertainty in the groundwater and groundwater to surface water pathway analyses, how large a source of uncertainty does the decision to use wastewater composition data appear to introduce into the overall study conclusions?

2.4 Procedural History of the Review

Barnes Johnson, Director, Economics, Methods, and Risk Analysis Division of the Office of Solid Waste requested the review during the SAB's Call for FY2001 (Check FY). The Environmental Engineering Committee considered this request at December 5-7, 2001 meeting. The Committee appointed Dr. Kim as chair of a Surface Impoundments Study Subcommittee originally to include Drs. Dellinger, Kavanaugh, Maney, McFarland, and Theis of the EEC. The EEC had done a consultation on the SIS for OSW in September 1996 and reviewed a plans for the study in 1997. The OSW also briefed the Committee about its study and noted that it had arranged for an external peer-review of certain elements of the study.

The EEC discussed the Surface Impoundments Study at two subsequent conference calls -- March 7 and May 2, 2001. During this period the review documents became available and a preliminary charge was drafted. Also, the SAB began to move towards a different approach towards Subcommittee formation known as "wide cast/narrow cast". Because the EEC had named Subcommittee members in December, a modified version of this new process was used to complete subcommittee formation. Also, as the charge became clearer and other demands were made on the members of the EEC, Drs. Dellinger and Theis were reassigned from the SIS Subcommittee to other activities.

3 RESPONSE TO THE CHARGE

3.1 Question #1: An overall review of the study

This section addresses the three questions raised by OSW in their charge and, where relevant, provides separate discussions for human health effects and ecological risks.

3.1.1 Does the SAB believe that the general methodology we chose for developing our risk analysis was appropriate for the policy questions posed in the statute and consent decree?

The relevant policy questions posed in the Land Disposal Program Flexibility Act (LDPFA) statute and consent decree were addressed by the Agency through the characterization of the human health and ecological risks associated with never characteristic and decharacterized wastes managed in surface impoundments. Although neither the regulatory statute nor the consent decree explicitly mandates a quantitative assessment of human health and ecological risks associated with management of wastes in surface impoundments, the Agency chose to conduct a multimedia risk assessment to characterize potential risk. The Subcommittee supports the Agency's decision to adopt this approach to risk characterization since a quantitative risk assessment provides Agency decision-makers with an effective means to not only quantify potential risks but also establishes a framework for defensible risk management decisions.

Although the Subcommittee endorses the general risk analysis methodology adopted by the Agency in addressing the specific policy questions, the specific steps that characterize the risk assessment methodology (including the number and types of assumptions) were found to vary significantly depending on the particular contaminant exposure pathway under consideration. The level of structural disparity associated with the various risk assessment methods suggests that the type and/or magnitude of uncertainty that characterize the final risk results may not be comparable across exposure pathways. To provide greater transparency in the formulation of the risk assessment methodology, the Subcommittee suggests that the Agency develop an influence diagram that clearly defines the structure of each exposure pathway risk assessment methodology, which includes the identification of key data inputs and type (*i.e.*, deterministic or probabilistic), intermediate variables, submodels used and the relationships that exist between the various components in the methodology.

The Subcommittee supports the Agency's decision to explicitly identify and characterize the major sources of uncertainty associated with each risk assessment methodology. Although a qualitative assessment of uncertainty is important to Agency

1 decision-makers, quantifying the impact of uncertainty (and variability) on the final risk
2 results provides the Agency with an invaluable tool for defensible risk management
3 decision-making. The Subcommittee recommends that the Agency establish a formalized
4 and transparent process to disaggregate and quantify the influence of uncertainty and
5 variability on all risk modeling estimates.

6 The Subcommittee supports the Agency's decision to employ the results from the
7 Land Disposal Restriction (LDR) program and the consent decree to identify the 256
8 chemicals or groups of chemicals that were evaluated in the current surface impoundment
9 study. However, human health risks were fully evaluated only for those chemicals for which
10 cancer potency values and non-cancer reference doses or concentrations were readily
11 available. Chemicals or exposure routes without such health risk indices were excluded
12 from the risk analyses. Similarly, the Agency neglected to account for the effects of
13 biophysical and photoconversion of chemicals (e.g., mercury to methylmercury) on the final
14 risk results.

15 To fully describe the potential risks associated with wastes managed in surface
16 impoundments, the Agency is encouraged to evaluate and document the impact of
17 excluding these chemicals on the final cancer and noncancer risk results. Furthermore, the
18 Subcommittee recommends that the Agency develop, where possible, defensible
19 approaches to generate surrogate health indices that could be used to estimate the cancer
20 and noncancer risk for all chemicals identified in the study as posing a potential risk when
21 managed in surface impoundments. In the absence of evaluating the risks associated with
22 all identified chemicals and their potential transformation products, there is limited
23 assurance that the chemicals posing the greatest hazards were actually captured by the
24 risk assessment. Finally, because of the variability associated with human health
25 response to chemical exposure, the Subcommittee recommends that the Agency consider
26 characterizing the distribution of risk associated with surface impoundments to determine
27 if these facilities represent a disproportional health concern for children and other high-risk
28 groups.

29 **3.1.2 Regarding the overall study implementation, from design through**
30 **sample selection, data collection and analysis, what areas of strength**
31 **do you see in the overall methodology, and what areas of potential**
32 **improvement or additional analysis do you recommend?**

33 **3.1.2.1 Human Health Risks**

34 The Subcommittee endorses the Agency's decision to employ a tiered approach
35 for characterizing human health and ecological risks. The use of preliminary risk
36 screening to eliminate constituents and/or constituent-impoundment combinations that are

1 associated with negligible risk from further quantitative analysis is a technically defensible
2 approach for optimizing the use of limited resources. The Subcommittee commends the
3 Agency for developing and implementing conservative assumptions within the risk
4 screening procedure that minimize the elimination of constituents that could potentially
5 represent significant risks to public health and the environment. Moreover, the
6 Subcommittee supports the Agency's use of a probabilistic approach for quantifying
7 human health risks associated with the groundwater exposure pathway. Employment of a
8 probabilistic risk assessment approach provides the Agency decision-makers with a
9 means of visualizing both the range of potential human health risk and the probability (or
10 confidence) that the risk will be observed.

11 Although the overall framework for the risk characterization was technically sound,
12 there were several procedural deficiencies that limit the use of the risk assessment results
13 in making defensible risk management decisions. A critical omission in conducting the
14 risk characterization studies was the failure of the Agency to explicitly establish an
15 acceptable level of quality for data used in both the risk screening as well as in the risk
16 modeling phases. Throughout the surface impoundment risk characterization study,
17 various sources of data (including survey data, sampling data, literature values, modeling
18 results, professional judgment *etc.*) were used to quantify the potential risks associated
19 with wastes managed in surface impoundments and to compare these results with defined
20 cancer, noncancer and ecological benchmarks. While the Agency is commended for
21 documenting the sources of these data, it is unclear from the description of the risk
22 assessment methodology whether the quality of the various data elements is of an
23 acceptable level to support Agency decisions. Moreover, the risk characterization
24 methodology neglects to describe how the uncertainty associated with data quality is
25 propagated through the risk assessment process and is captured in the final risk modeling
26 results.

27 The Subcommittee recommends that the Agency explicitly establish the appropriate
28 level of quality for all data used in developing quantitative risk characterization results.
29 This recommendation is consistent with EPA Order 5360.1, which requires that all EPA
30 organizations follow a systematic planning process to develop acceptance criteria for the
31 collection, evaluation and use of environmental data. Acceptance criteria are based on
32 the ultimate use of the data and the required quality assurance (QA) and quality control
33 (QC) practices required to support a decision. An effective approach for establishing the
34 minimum level of acceptable data quality is through the application of the Agency's data
35 quality objectives (DQO) process (EPA QA/G-4 – EPA/600/R-96/055). The DQO process
36 is a scientifically based methodology used for defining the data quality requirements that
37 are appropriate for the intended use of the data. The output of the DQO process is a data
38 collection design that clearly defines the type, amount, and quality of data required to
39 support a decision.

1 The Subcommittee supports the Agency's use of a probabilistic risk
2 characterization approach for quantifying the human health risks associated with the
3 consumption of contaminated groundwater. Use of the probabilistic approach allows
4 Agency decision-makers to evaluate the full range of potential human health risk as well as
5 their probability of occurrence. In addition to establishing both the range and probability of
6 certain risk, probabilistic analysis can be used to identify the key sources of variability and
7 uncertainty in model inputs. When both the uncertainty and variability associated with
8 input parameter values are significant, the output of a contaminant exposure model
9 represents a hybrid distribution that contains some combination of true variability and
10 uncertainty reflecting a lack of knowledge. Therefore, a quantitative evaluation of
11 uncertainty (and, in some cases, variability) is critical for the proper interpretation of risk
12 results as well as for the purposes of targeting further data collection and/or research.
13 Because of its importance in interpreting risk results, the Subcommittee recommends that
14 the Agency develop and implement a process to quantitatively evaluate the impact of
15 uncertainty.

16 Finally, in evaluating the groundwater to surface water contaminant exposure
17 pathways, infiltration rates were developed by employing the Hydrologic Evaluation of
18 Landfill Performance (HELP) model, which used regionalized climatic and generalized
19 soils data rather than site-specific information. Although the Agency states that the HELP
20 model accounts for uncertainty in infiltration rates using a probabilistic simulation, the
21 HELP model described in *Hydrologic Evaluation of Landfill Performance (HELP)*
22 (EPA/600/R-94/168b) is not probabilistic but, rather a two-dimensional deterministic
23 model used to perform water balances. The Subcommittee encourages the Agency to
24 provide additional documentation describing the version of the HELP model used in the
25 risk characterization methodology.

26 **3.1.2.1 Ecological Risks**

27 The screening-level ecological risk assessment does not fully characterize risks to
28 the environment. Following the ecological risk assessment, the reader is still very
29 uncertain about the credibility of ecological risks associated with surface impoundments.
30 EPA should be more specific about why only the screening-level risk analysis was
31 performed; Sect. 3.5 does not state a justification. For example, the agency could state all
32 of the areas of exposure and effects estimation that are unknown because of a lack of
33 data. However, the Subcommittee encourages the Agency to provide a more accurate
34 and complete characterization of exposure; for example by using transport equations from
35 the human health risk assessment, and thus get closer to answering the question posed in
36 the LDPFA.

1 The Subcommittee recommends that a more refined or definitive assessment be
2 conducted (*i.e.*, a Phase II assessment similar to that proposed in the *Technical Plan* –
3 EPA 2000 previously reviewed by the SAB). The Agency states that a facility with
4 impoundments that exceed the ecological risk criterion for one or more chemicals are
5 carried forward for further analysis (p. C-159). Similarly, the Agency states that surface
6 impoundments hazard quotients of one or greater may be assigned for further evaluation,
7 depending on the results of the human health screening. The nature of the further analysis
8 is not described, nor its scientific or policy connection with the human health screening.
9 The following areas of potential improvement or additional analysis are recommended that
10 relate to the ecological risk assessment:

- 11 a) The use of transport or multimedia models to improve exposure predictions
- 12 b) The use of realistic home ranges for terrestrial vertebrates (the impoundment
13 would represent a portion of the diet for most potential receptors)
- 14 c) The use of realistic bioaccumulation models or factors for wildlife foods in
15 sludge/soil matrices
- 16 d) The improvement of the scientific basis for the decision to use a higher
17 threshold HQ (*e.g.*, 10 rather than 1) for potential risk of SI contamination to
18 the plant community (p. C-178, are plants unique in their adaptation ability?
19 (Are sludge/soils expected to support any vegetation cover?))
- 20 e) The use of realistic assumptions about piscivore diets (what fraction of these
21 surface impoundments really have a fish community dwelling in them that
22 would support a population of piscivores?)
- 23 f) The possible use of more recent extrapolation models for vertebrate toxicity
- 24 g) A more detailed explanation (preferably, with references) of why the air
25 pathway is not a credible pathway for exposure to ecological receptors (*e.g.*,
26 the direct uptake of semivolatile chemicals such as PCBs, PAHs, and
27 elemental Hg by plant leaves may be more important than the uptake through
28 the roots, even if the only source is from soil)

29 **3.1.3 Did EPA adequately characterize the risks? Are the risk analysis and**
30 **findings transparent? That is, are they explicit in:**

31 **Describing the assessment approach, assumptions, extrapolations**
32 **and use of models**

Describing plausible alternative assumptions

Identifying data gaps

Distinguishing science from policy

Describing uncertainty

Describing the relative strength of the assessment

3.1.3.1 Human Health Risks

In general, the tiered approach adopted by the Agency for characterizing human health and ecological risks associated with wastes managed in surface impoundments was appropriate and technically defensible. However, its implementation was inadequate to fully characterize risks and, therefore, the estimated risks associated with the various exposure pathways may have limited value in supporting Agency risk management decisions. Two critical deficiencies associated with the overall risk characterization approach included the absence of: 1) clearly defined quality criteria established for each type of data element and 2) a technically defensible and transparent process for quantifying the impact of uncertainty (and variability) on final risk modeling results.

The preliminary screening approach (Phase IA) used to quantify the risks associated with the air inhalation pathway, groundwater to surface water pathway and the indirect exposure pathway effectively eliminated those constituents that represented insignificant risks. However, as the risk characterization analysis progressed from the risk screening to the release assessment and risk-modeling phases, the methodology lacked the transparency required to fully evaluate the accuracy of the final risk results. Moreover, the Agency's decision to conduct a probabilistic risk assessment for the groundwater exposure pathway and not for the other contaminant exposure pathways including air inhalation, groundwater to surface water and indirect exposure pathway is not supportable given the Agency's extensive use of probabilistic modeling in other regulatory programs (e.g., Hazardous Air Pollutants Residual Risk Program – EPA-453/R-99-001).

The EPA screening models including the industrial waste air model (IWAIR) and the industrial waste exposure model (IWEM) were used to calculate screening risk estimates associated with the air inhalation and groundwater surface impoundment exposure pathways. Each of these models, in turn, depends on the output from other models. For example, IWAIR is a deterministic model that utilizes: 1) the output from the CHEMDAT8 volatile emission model to calculate the constituent release (*i.e.*, emission rate) from an

1 impoundment, 2) the dispersion factors developed from the Industrial Source Complex
2 Short Term (ISCST3) model to calculate an air concentration and 3) EPA risk assessment
3 guidance to conduct an exposure and risk calculation.

4 The Subcommittee supports the Agency's decision to assign standard EPA
5 exposure factors to specific parameter values (e.g., inhalation rate, body weight, exposure
6 duration, etc.) for quantifying long-term chronic health risk. However, since specific
7 environmental and facility management factors (e.g., contaminant concentration, level of
8 aeration, pH, wind speed, temperature, etc.) can have a significant effect on contaminant
9 emission rates, the Subcommittee encourages the Agency to quantitatively evaluate the
10 sensitivity of the CHEMDAT8 model output to changes in the values of input parameters.
11 Moreover, for those parameters identified to have a significant impact of CHEMDAT8
12 model output, the Agency should consider capturing and propagating the uncertainty
13 associated with those parameters with the risk assessment methodology through the
14 development of probability distributions.

15 The IWEM model employs a Monte Carlo probabilistic approach to develop
16 statistical distributions of various parameters that impact the fate and transport of
17 contaminants associated with the groundwater exposure pathway. Once the probabilistic
18 distributions are assigned, the IWEM model employs the EPA Composite Model Leachate
19 Migration with Transformation Products model (EPACMTP) to compute the groundwater
20 monitoring well concentration and the dilution attenuation factor (DAF) at 150 meters from
21 the source along the centerline of the plume. Three two-parameter probability statistical
22 distributions (gamma, lognormal and Weibull) were used to model the distribution of values
23 of critical parameter values used in the groundwater pathway simulation.

24 Although the Subcommittee supports the Agency's use of a probabilistic approach
25 for characterizing the risks associated with the groundwater exposure pathway, a detailed
26 description of the methodology was not provided. Specifically, the process used to select
27 which groundwater fate and transport parameters were to be modeled probabilistically and
28 how the shape of the distributions were determined were not described in the risk
29 assessment methodology. Furthermore, for those parameters that were modeled
30 probabilistically, the Agency should provide explicit descriptions of: 1) how functional
31 dependencies of input parameters were modeled and 2) the technical process for
32 determining the locations for probability distribution truncation. Finally, because of the
33 importance in direction of groundwater flow in characterizing risk associated with the
34 groundwater exposure pathway, the Subcommittee encourages the Agency to provide a
35 transparent and detailed description of the process used by experts to assign flow
36 direction and how the uncertainty associated with "professional judgment" was captured in
37 the final risk modeling results.

1 The indirect exposure pathway analysis considered a set of exposure pathways,
2 each linked to a specific release scenario and receptor population. For example, the
3 human health risks associated with indirect contaminant exposures associated with
4 contaminant volatilization, particle entrainment, erosion/runoff and groundwater to surface
5 water recharge were evaluated using a set of facility specific and environmental setting
6 criteria, which in turn, served as input parameter values in a risk ranking algorithm. The
7 ranking algorithm was used to generate and overall ranking for the specific exposure
8 pathway.

9 The ranking algorithm used a process of assigning arbitrarily established risk
10 criteria values using surrogate data that ranged from (1) to (3) with (1) representing lower
11 risk facility specific or environmental setting conditions, (2) representing intermediate
12 conditions and (3) representing higher risk conditions. The risk criteria were summed to
13 rank the importance of specific exposure pathways for indirect exposure for each facility-
14 impoundment combination. Facilities were placed in an appropriate "bin" reflecting the
15 magnitude of their indirect exposure risk.

16 The Subcommittee encourages the Agency to eliminate the use of binning to
17 identify and characterize indirect exposure high-risk surface impoundments. The principal
18 concerns associated with the use of binning are that the method is not only inherently
19 biased and uncertain but the risk results may reflect a level of accuracy that does not exist
20 and could be misinterpreted and/or misapplied.

21 Risks may not be adequately characterized. Because of the large uncertainties and
22 omissions the quantitative estimates of risk do not appear reliable. In assessing potential
23 health effects, plausible alternative assumptions are not explored. The uncertainties in the
24 health parameters and associated with the presumed endpoints affected are not well
25 described.

26 **3.1.3.2 Ecological Risks**

27 *Describing the assessment approach, assumptions, extrapolations and use of*
28 *models* – The ecological risk assessment is generally explicit in describing the
29 assessment approach, assumptions, and extrapolations.

30 *Describing plausible alternative assumptions* – Explicit, plausible, alternative
31 assumptions were not really relevant to the ecological screening analysis

32 *Identifying data gaps* – The ecological risk assessment does not directly identify
33 many of the data gaps. The only factor mentioned under data gaps is the lack of data
34 available to develop screening concentrations for many chemicals (p. 3-46). However,

1 EPA recognizes elsewhere (e.g., in discussions of uncertainty), that numerous data gaps
2 exist in both the characterization of exposure (relevant abiotic media concentrations,
3 uptake factors) and the characterization of effects, particularly related to toxicity of
4 soil/sludge. This question is also addressed in the response to question 3a on research
5 priorities.

6 *Distinguishing science from policy* -- EPA does a good job of distinguishing
7 science from policy. For example, EPA translates the terms A human health and A the
8 environment from the study purpose as described in the LDPFA and the consent decree
9 (p. 1-8) into very specific human health and ecological endpoints and assumptions.

10 *Describing uncertainty* -- The risk assessment results are explicit in qualitative
11 descriptions of uncertainty, but not quantitative characterizations of uncertainty.
12 Quantitative estimates of uncertainty would be preferable, where possible, particularly if a
13 more definitive ecological risk assessment is performed [Guiding Principles for Monte
14 Carlo Analysis EPA/630/R-97/001, Summary Report for the Workshop on Monte Carlo
15 Analysis EPA/630/R-96/010].

16 The Subcommittee commends the Agency for appropriately recognizing that the
17 ecological risk characterization and indirect pathway risk characterization are less certain
18 than the characterization of [human health] risks via air, groundwater, and groundwater to
19 surface water (p. ES-3). The high level of uncertainty associated with the screening
20 ecological risk assessment is also acknowledged in Sect. 3.5.2.1 (p. 3-43). It should be
21 noted that this degree of uncertainty applies to those facilities identified as having a
22 potential for ecological risk (including those of A lower concern). Screening-level risk
23 assessments rarely have false negative results, and there is no evidence that this
24 ecological assessment lacks conservatism, so facilities that are screened out as having
25 the least potential for risk are almost certainly not of concern.

26 The discussion of uncertainties associated with the ecological risk assessment in
27 Sect. 3.5.3 and Sect. C.1.9.2 are generally thorough, and the distinction of uncertainties as
28 parameter uncertainties, modeling uncertainties, and results uncertainties is useful. Under
29 Sect. 3.5.3.1, Assumptions on Dietary Exposure, the Subcommittee recommends that the
30 EPA discuss the uncertainty associated with uptake factors for wildlife foods. When
31 compared to values from national-scale studies (e.g., BJC 1998), the uptake factors
32 selected for several inorganic chemicals do not seem conservative, and are highly
33 uncertain. Under Sect. 3.5.3.2, Constant Chemical Concentration, we would suggest that
34 EPA explain why a constant chemical concentration will tend to overpredict the potential
35 risks to wildlife. Under Sect. 3.5.3.2, single chemical exposures, we would suggest that
36 EPA explain the potential for possible multiple chemical effects and the likelihood (based

on existing literature) that toxicity of multiple chemicals is additive, less than additive or synergistic.

Describing the relative strength of the assessment

This question is somewhat vague. Obviously, conclusions from a refined ecological risk assessment are more precise than those from a screening-level risk assessment. Therefore, EPA is unable to make strong conclusions related to ecological risks. Few facilities and chemicals are screened out, which could mean either that surface impoundments have high potential for ecological risk or that the assessment is weak in not recognizing a low risk potential.

3.1.4 Please provide your assessment of the accuracy of EPA's overall study conclusions regarding risk to human health and the environment. Were the conclusions either false positive or false negative conclusions (finding risks of greater or lesser magnitude than the risks that likely exist)?

3.1.4.1 Human Health Risks

In general, the Subcommittee supports the level of accuracy associated with the screening level risk characterization. The use of conservative assumptions minimized the elimination of surface impoundments that could potentially represent significant risks to human health and the environment. The Subcommittee supports the Agency's decision to adopt conservative assumptions within the risk characterization process that will overestimate the risk and thus provide greater protection to public health and the environment. However, in many instances, potentially important contaminant fate and transport pathways (e.g., groundwater colloidal and fracture flow, exposure of groundwater contaminants through inhalation, etc.) were not addressed within the risk assessment methodology. The Subcommittee encourages the Agency to evaluate the uncertainty associated with final surface impoundment risk results when these specific pathways are neglected.

With respect to the contaminant release assessment and risk modeling methodologies, the absence of established data quality criteria and quantitative estimates of risk uncertainty limited the ability to effectively evaluate the accuracy of the final risk estimates. The Subcommittee recommends that the Agency provide greater transparency in its description of both the types and quality of data used to support the contaminant release assessment and risk modeling efforts.

1 There are a number of biases in the methodology used to estimate health risk
2 contributing to false negative conclusions. These include the limited chemical selection,
3 endpoint selection, assignment of zero potency and hazard for specific chemicals and
4 routes in the absence of readily available indicators. As one example, from tables in
5 Appendix C it appears that numerous chemicals were presumed to pose no cancer risk by
6 any route (e.g., cobalt compounds, glyceraldehydes, lead, 1,4-dioxane, styrene oxide,
7 styrene, naphthalene, and numerous others) or no risk by a given route (i.e., various
8 Polycyclic aromatic hydrocarbons, dimethylbenzidine, dimethoxybenzidine,
9 pentachloronitrobenzene, hexavalent chromium, 1,3-butadiene, and numerous others) even
10 though there are data suggesting other hypotheses are plausible. Other Appendix tables
11 indicate that a number of non-cancer effects overlooked for specific chemicals.

12 **3.1.4.2 Ecological Risks**

13 The study results for ecological risk assessment are accurate in the sense that the
14 range of potential risks that is described encompasses all of the likely risks. However, as
15 with most screening-level risk assessments, many of the potential risks are likely to be
16 false positive conclusions, and the fraction of potential risks remaining at the conclusion of
17 the ecological risk assessment (involving 34 of 35 or 43 chemicals for which toxicity data
18 are available and 54 or 62 potential receptors) is high.

19 A major concern, however, is that summaries and conclusions state that only 29%
20 of the facilities had potential ecological risks. Because EPA's definition of potential risk
21 (i.e., facilities with potential risk for which more than 38 receptor exceedances were
22 observed, p. C-46) is much narrower than the literal definition of potential risk, a large
23 fraction of potentially risky facilities is excluded, leading to possible false negative
24 conclusions. Approximately 92% of facilities have potential ecological risk.

25 **3.2 Question #2: Abnormal Operating Conditions – Should EPA have performed** 26 **a more in-depth evaluation of abnormal operating condition events?, If so,** 27 **what methods or approaches would the SAB recommend regarding** 28 **collecting more reliable data, and modeling the probability and impacts of** 29 **such events?**

30 In response to this charge question, the Committee understands that it needs to
31 address the following issues: completeness of the list of abnormal operating scenarios
32 used by the Agency for risk assessment; the effects of non-consideration of relevant
33 factors and scenarios on computed risk estimates; and the approach(es) that the Agency
34 may adopt to incorporate factors and scenarios that are not presently covered by the
35 current risk assessment methodology. The term "abnormal operating conditions" is not
36 explicitly defined in the document by the Agency. The Committee defines this term as

operating conditions in which there are changes in wastewater characteristics, severe weather or structural failure of one or more critical components of the surface impoundment. Abnormal operating conditions can influence the magnitudes of the source term concentrations of contaminants and hence, impact upon the rates at which contaminants migrate from the impoundment into the ambient environment.

The internal zonation of the constituents of a surface impoundment may also be a factor in the release potential of contaminants under abnormal operating conditions. Regardless of whether or not an impoundment is used for direct discharge, it usually consists of an active zone comprising the bulk of the volume of the containment, a sludge zone of minimal volume and contaminated liner or soil at the base. An abnormal operating condition of sufficient intensity can affect the processes and flow out of one or more of the zones.

The Agency has adopted two complementary approaches to estimating both ecological and human health risks posed by surface impoundments. In one approach, monitoring data are used to determine contaminant source terms. In another approach, source terms are estimated using models and judgment for use in predicting future risk. Although it may be necessary for the Agency to determine how abnormal operating conditions may have affected the monitoring data collected in the first approach, it is not necessary for the Agency to modify the data on considerations of abnormal operating conditions. The effects of these conditions are already reflected in the monitoring data. For the second approach which involves predictions of impoundment performance in the future and the impact of abnormal operating conditions on source terms and future human health and ecological risks, it is important that such impacts be analyzed and incorporated into the estimates of risk. This is the focus of the recommendations presented here in response to charge question # 2.

3.2.1 Types of Abnormal Operating Conditions and the Necessity to Address them.

For the design categories, locations and management systems of the impoundments described in this study, the Committee has determined that the abnormal operating conditions described below should be considered in the analysis of risks associated with the performance of the impoundment.

3.2.1.1 Changes in wastewater characteristics.

Wastewater that enters an impoundment may undergo major changes in characteristics due to accidental spills or changes in production practices. Possible manifestations of these changes are changes in pH (that could still be within the

acceptable range), and release of chelating agents or fine particulates. Metals can be solubilized as a result of pH changes, with a consequent decrease in their breakthrough times as they travel through the liner of an impoundment. Direct chemical attack of liner materials under aggressive pH conditions is also a possibility. The release of chelating agents can also lead to an increase in the concentration of metals in the effluent and possibly, increased breakthrough of metals through the liner. Fine particulates settle very slowly in aqueous media and can mobilize contaminants through adsorption and / or ion exchange mechanisms into the effluent. These phenomena are not addressed in the modeling effort described in the document. The risks associated with these phenomena should be accounted for and appropriate safety factors incorporated in the predictive methodologies, if necessary.

3.2.1.2 Storm events

In the report, it is stated that most surface impoundments receive stormwater. Increased flow of water into an impoundment due to a storm event can, in addition to causing the release of poorly managed wastewater, scour the sludge zone of the impoundment and discharge elevated concentrations of contaminants from the sludge zone. For example, a 100-year storm can wash out previously settled contaminants from the sludge zone. It is herein recommended that watershed modeling approaches that cover high-impact storms of appropriate return periods be integrated into the methodology to address risks associated with stormwater influx into impoundments. The Agency should also collect empirical information from the regions on surface impoundment failures during the past 10-20 years. Some case-histories may be available on impoundment failures due to storms in North Carolina and Colorado. Such information may be useful for calibrating facility failure and contaminant transport models.

3.2.1.3 Structural failure due to seismic events

Seismic events such as earthquakes can threaten the structural integrity of impoundments. A confining berm or dyke could fail due to ground shaking in earthquake-prone regions. Such failures would cause an immediate release of contaminants into the subsurface or over land. The Committee has noticed the absence of seismic considerations in Table 4.4. An assessment of the design and geographic distribution of impoundments vis-à-vis earthquake zones is necessary in order to establish the risk of catastrophic failures within the timeframes of concern. This is particularly important because the period of coverage of the risk analysis is as long as 10,000 years.

3.2.2 Adequacy of the Methodology used to Analyze Risks Posed by Surface Impoundments

1 Except for non-coverage of abnormal operating conditions, the Agency has done an
2 excellent job of quantifying the linkages among numerous factors as needed, to estimate
3 both human health and ecological risks posed by surface impoundments. Particularly, data
4 on several impoundment characteristics have been gathered, disaggregated and analyzed to
5 establish how impoundments have performed during and after their service lives. The
6 deficiency found is in the coverage of possible scenarios that will influence the accuracy of
7 the predictions of future performance of the impoundments and by extension, future risks to
8 human health and the environment.

9 The abnormal operating conditions described in the preceding section influence the
10 magnitudes of the contaminant source concentration terms. Source term concentration
11 estimates need to be reasonably accurate because in turn, they are input data, for use in
12 contaminant migration and risk assessment models. Indeed the Agency acknowledges the
13 criticality of source terms by stating in page C-13 of the document, "one of the most
14 sensitive parameters in risk modeling is the source concentration term. Frequently, this
15 term is associated with a high level of uncertainty because (1) the data on concentration
16 may not be sufficient to characterize the variability due to changing waste streams,
17 impoundment conditions, and other characteristics; and (2) the analytical methods may be
18 insufficient to quantify the concentration term...". In the second paragraph of Appendix
19 page C-93 of the document, the Agency further states that "the release of contaminants
20 into the subsurface constitutes the source term for the groundwater fate and transport
21 model. Because the modeled subsurface fate and transport processes are the same for
22 each waste management scenario, the conceptual differences between different waste
23 management scenarios are reflected solely in how the model source term is characterized"
24 The Committee agrees with the Agency on these assertions and wonders why an
25 assessment was not made and reported by the Agency on how the selected risk
26 assessment framework covers the effects of abnormal operating conditions on
27 contaminant source terms and hence risk estimates.

28 Except for the case of changes in wastewater characteristics, the Committee does
29 not advocate a generic modification of contaminant concentration source terms to
30 accommodate the impacts of transient events in the risk assessments. There are specific
31 regions of the United States where transient events of significant magnitudes are known to
32 have elevated frequencies. As examples, earthquakes are prevalent in the West Coast
33 and Central USA; and storms / floods are more frequent in the Southeast and Midwest. It is
34 noteworthy that there is an overlap of these high hazard zones over relatively high
35 concentrations of impoundments. Figure 1 (designated as Figure 2-2 on page 2.4 of the
36 Agency report) shows that there are 1035 impoundments in the West Coast, 434 in Alaska
37 and 601 in Hawaii where seismic events are relatively frequent; and 4103 impoundments
38 in the Southeast where annual precipitation and storm frequencies are relatively high.

1 The EPACMTP model, which was used by the Agency to perform contaminant fate
2 and transport analysis for risk modeling, is reasonably adequate provided input data are
3 appropriate. The mathematical architecture of this model was previously reviewed by the
4 USEPA Science Advisory Board. The model is appropriate for use in performing fate and
5 transport analyses and not for contaminant release source term from multi-component
6 constructed facilities like surface impoundments. It should be noted that contaminant
7 source term concentrations need to be determined either through the use of monitoring
8 data or predictions of contaminant release rates / events using containment system failure
9 / liner permeation models, for input into the risk models. As indicated by the Agency in
10 Figure 2. (designated as Figure 3.1 on page 3.3 of the Agency report), the release
11 scenarios that are considered to impact upon source terms are volatilization / dispersion,
12 leaching and erosion / run off. Analyses are likely to show that for some impoundments
13 located in the regions mentioned in the preceding paragraph, this suite of release
14 scenarios is incomplete. Furthermore, it should be stated under "model simplifications" on
15 page 3-18 of the report that EPACMTP does not model the impacts of transient events.

16 On page 3-18 of the Agency report, it is stated that "the risk to receptors for the
17 groundwater pathway was evaluated over a time period of 10,000 years". This timeframe
18 is long enough for the occurrence of very high-impact storms and seismic events at least
19 in the active regions identified. Furthermore, most components of surface impoundments
20 would have deteriorated to ineffective levels of performance within 200 years unless they
21 are maintained or re-built. This does not imply that the service life of impoundments is 200
22 years. The actual service life depends on facility design, facility location, operational
23 conditions including the impact of transient events, and the types of wastes impounded.
24 Although contaminant arrival at reception locations can trail releases from facilities by
25 several decades, it is necessary to conduct a general assessment of the need to account
26 for the presence of liners in scenarios where long exposure timeframes are considered.

27 **3.2.3 Data Needs for More Adequate Treatment of Abnormal Operating** 28 **Conditions**

29 The Agency has collected a significant amount of valuable data on surface
30 impoundments. On the assessments that it has conducted regarding the performance of
31 impoundments, it has done a reasonably thorough job. In order to perform additional
32 assessments that are necessary but absent in the report presented by the Agency for
33 review by the Committee, follow-up analysis of the existing data and collection of additional
34 regional data from mostly public agencies are necessary. For example, impoundment
35 overtopping failures due to storms are known to have occurred in the Carolinas. Relevant
36 information from that region may help in establishing the pattern of failures.

1 The Agency has already collected facility design and contents data. It has also
2 supplemented these data with synthetic data estimated using empirical information
3 developed by several researchers. In the bottom paragraph of page 1-1, the Agency
4 acknowledges that it performed a comprehensive census of agricultural, mining, industrial
5 and municipal surface impoundments in the late 1970s and the early 1980s, including
6 characterization of about 30,000 impoundments with respect to their geographic
7 distribution, sizes, functions and potential for groundwater contamination. Unfortunately, the
8 Agency notes that these data were not used to support the analysis presented in this report
9 because they were not available. The information to which reference is made above may
10 be useful in determining the pattern of impoundment performance, especially if a
11 significant number of the impoundments characterized are located in high hazard zones.

12 Hazard zonation information is needed. For a significant number of impoundments,
13 the Agency has information already for addressing possible changes in wastewater
14 characteristics. Where site-specific data are needed, the Agency can use ranges of
15 synthetic data drawn from the realm of experience in the magnitudes of transient events
16 that have occurred / or are likely to occur in the region as well as the predominant
17 geotechnical characteristics of sites in the region. In the case of overtopping due to
18 storms, there may be useful information in the regions, especially in North and South
19 Carolina. Incidentally, the Agency has collected and used relevant data in this report for a
20 different purpose. In section A.3.1.3 of page A-28, the Agency acknowledges that it used
21 GIS to screen information on sites for the purpose of performing ecological risk modeling.
22 The spatial relationships between each impoundment site and the following factors were
23 considered: managed areas, landuse categories, permanently flooded woodlands,
24 Bailey's ecoregions, fishable water bodies, soils and groundwater geology. Among the
25 resources used for information were regional geologic maps, state soil survey maps and
26 watershed maps. These data and resources need to be used again to analyze the
27 potential impacts of storms / floods and seismic activities on contaminant source terms.
28 Ground acceleration (seismic) maps of high seismic hazard zones are obtainable from the
29 U.S. Geological Survey while flood frequency maps are available at the Federal
30 Emergency Management Agency. It should be noted that event frequency maps alone are
31 not adequate for use in predicting impoundment failures due to transient events. Such
32 frequency maps are generally used to address geohazards risks that define the
33 magnitudes and associated return periods of stressing events. The spectra of expected
34 stresses within the period of consideration (in this case up to 10,000 years) would then be
35 used to analyze the reliability of the most common designs and expected (probable)
36 releases. This type of analysis feeds into the exposure assessment and is quite commonly
37 done in dam safety assessments.

38 **3.2.4 Recommendations on Approaches to Incorporating Assessments of** 39 **Abnormal Operating Conditions**

1 A useful approach to incorporating the effects of transient events (storms and
2 seismic events) and changes in wastewater characteristics on risks posed by surface
3 impoundments is the estimation of likely changes in the magnitude of the contaminant
4 concentration source term. If the impoundment fails catastrophically in the high hazard zone
5 or becomes ineffective due to aggressive wastewater characteristics, there should be an
6 increase in contaminant source term concentrations for the relevant pathways.

7 The challenge for the Agency, is the development of a scheme for estimating the
8 magnitude and rate of increases in source terms in response to these abnormal operating
9 conditions. Some suggestions on the approaches that the Agency may adopt to address
10 the impacts of abnormal operating conditions on source terms are presented below.

11 **3.2.4.1 The Factor of Safety Approach**

12 Similar to the traditional approach used in structural design, the Agency may elect
13 to apply empirical safety factors to source term concentrations in scenarios and zones of
14 abnormal operating conditions. Such factors, which would have the net effect of increasing
15 the source term, should be directly proportional to the most probable intensity or
16 magnitude of the event or phenomena within the timeframes and locations of interest. If
17 available, historical data can be used to support the indexing system.

18 **3.2.4.2 The Zero Containment Assumption**

19 Under abnormal operating conditions that are of high intensity or frequency, the
20 Agency may assume that the containment system will not exist after certain specified
21 service timeframes. For the groundwater transport pathway, this is tantamount to the
22 assumption that the contaminant source term at locations immediately around the
23 impoundment are the same as the concentrations of the target contaminants within the
24 impoundment. This should be considered to be a conservative assumption.

25 **3.2.4.3 Impoundment Degradation and Contaminant Release Modeling**

26 This approach involves a more systemic analysis of the response of components of
27 the impoundment to various levels of stress imposed by the transient events or
28 contaminant release / chemical attack by contents of the impoundment. Essentially, a
29 quantitative relationship needs to be established between the degradation of the
30 significant components of the containment with time under the expected magnitude of the
31 transient event. With increase in the permeability or hole size / density of the impoundment
32 liner following a transient event, contaminant release rates would be high. Appropriate
33 models can then be used to estimate the growth in the source term in response to the slow
34 or abrupt increase in contaminant release volume. Probabilistic analyses of potential

damages cannot be avoided if this approach is adopted. Relevant issues have been described by Bass et al. (1985), Iman et al. (1990), Inyang and Tumay (1995), Inyang (1994), Peterson (1990) and Inyang et al (1995)

REFERENCES

1. Bass, J.M., Lyman, W.J. and Tratnyek, J.P. 1985. Assessment of synthetic membrane successes and failures at waste storage and disposal sites. Project Summary, EPA/600-S2-85/100. U.S. Environmental Protection Agency, Washington D.C.

3.3 Question #3 Screening-level risk characterizations

3.3.1 Overview

A screening-level risk assessment is generally intended to determine the scope of a definitive or higher-tier risk assessment by eliminating from further consideration chemicals, receptors, and/or facilities that are clearly not associated with a potential risk. EPA presented results from two screening-level analyses to determine the potential for risk to human health from indirect pathways and to determine the potential for ecological risk from all pathways considered. Indirect pathways for human exposure and ecological exposure were not considered in a more definitive risk assessment.

In summary, the methodologies for the screening-level risk characterizations were, for the most part, clearly presented. However, the Subcommittee recommends that EPA 1) reevaluate the use of binning for ranking facilities that may represent a significant indirect exposure risk, 2) better define the technical terms used to differentiate the levels of indirect and ecological risk, 3) better characterize ecological exposure in the screening or more detailed risk assessment, and 4) better characterize and ultimately reduce uncertainty in exposure (e.g., chemical transformation) and effects through additional secondary data-gathering and research.

3.3.1.1 Indirect Human Exposures

To investigate the risk of potential indirect exposures to human receptors through pathways such as ingestion of crops, dairy products and fish that might be contaminated through runoff from closed impoundments, or air dispersion onto nearby farmlands, EPA conducted a screening level risk characterization. In contrast to a formal risk assessment, this analysis consisted of a categorizing and ranking of exposure factors of potential concern for each facility in order to identify facilities where indirect pathways may be of potential concern.

1 In the first stage of the indirect screening, EPA reviewed the constituents reported
2 in the surveys to identify a short list of bioaccumulative constituents for indirect exposure.
3 The second stage of the screening analysis was to identify all facilities that reported
4 managing these constituents and to screen these facilities according to their potential for
5 indirect exposures. The criteria considered included size of the surface impoundment,
6 distance from the impoundment to the nearest receptor, slope of the terrain in the vicinity of
7 the site, and size of nearby water bodies. The rankings assigned to these facilities were
8 based exclusively on an assessment of current site-conditions, including both
9 impoundment status and environmental setting criteria in the vicinity of the facilities.
10 However, a future closure scenario was also included in the analysis to address potential
11 risks following impoundment closure.

12 Once the screening had been completed to identify facilities where indirect
13 pathways were of potential concern, EPA generated national estimates of the proportion of
14 facilities that could pose concerns due to indirect pathway exposures. The measures used
15 are as follows:

- 16 a) *Potential Concern.* This risk metric is an indicator of the potential for
17 completion of more than one indirect exposure pathway at the facility.
- 18 b) *Lower Concern.* This risk metric is an indicator of the potential for
19 completion of one indirect exposure pathway at the facility and, therefore, of
20 relatively lower concern.
- 21 c) *Least Concern.* This risk metric is an indicator of low potential to complete
22 even one indirect exposure pathway at the facility.

23 Six percent of facilities fell into the potential concern category for indirect exposure.
24 EPA found that the qualitative character of the indirect exposure pathway analysis led to
25 several major areas of uncertainty that affected their interpretation of the results. EPA
26 concluded this degree of uncertainty was acceptable for a first-pass assessment as to
27 whether individual facilities have the potential for indirect exposure pathway risk. They
28 found that the use of the screening methodology precludes drawing any conclusions
29 regarding the potential magnitude of risk that these facilities could pose either now or in
30 the future.

31 **3.3.1.2 Potential Ecological Concerns**

32 EPA conducted a screening level risk characterization of potential ecological
33 concerns. This assessment identified facilities where there could be ecological concerns

provided there were direct contact and/or ingestion of surface impoundment contents by various ecological receptors, using conservative screening assumptions.

The ecological risk screening was similar to the first screening stage of the human health risk analysis, but did not go beyond that stage to consider actual exposures, and did not rely on fate and transport modeling. The assessment strategy was intended to represent only the potential for adverse ecological effects, not the actual risk posed to ecological receptors. A screening assessment was performed to estimate the potential risk for a wide variety of categories of plants and animals. EPA assigned receptors to each facility based on regional data sources and land use characteristics at each facility. The assessment compared chemical concentrations in surface impoundment water and sludge to concentrations that are considered protective of animals and plants. Risk was assessed for numerous birds, mammals, and amphibians as well as for soil, aquatic, and sediment communities (e.g., earthworms, fish, and insect larvae). Aquatic and terrestrial plants were also assessed. An additional element of the ecological screening considered whether surface impoundments are located near sensitive ecosystems such as wetlands, wildlife refuges, or national forests.

In the final stage of the screening-level assessment EPA compared the number of each facility's risk exceedances to the median number of exceedances (38 exceedances) for all the facilities that did not screen out. Using this standard, facilities that exceeded screening levels were placed in two categories:

- a) *Potential concern.* Facilities having at least the median number of exceedance for ecological receptors (i.e., 38 or more exceedances).
- b) *Lower concern:* Facilities having fewer than the median number of exceedances for ecological receptors.

EPA found that a total of 34 chemicals exceeded the risk criteria for at least one receptor at one impoundment, and 54 of the more than 62 ecological receptors considered showed potential risk exceedances. These receptor taxa include mammals, birds, and plants, as well as soil, aquatic, and sediment communities. EPA found that the screening nature of the analysis led to several major areas of uncertainty that affect interpretation of the results.

3.3.2 Responses to Charge Questions

3.3.2.1 Question 3 a: For the indirect human health and ecological screening-level analyses do the results point to areas of

**potential future research? If so, do you have
recommendations on prioritizing future studies in these areas?**

The following areas of future research are recommended to decrease uncertainty in risk assessments related to surface impoundments:

- a) The empirical study of the fate and transport of chemicals in and around aqueous surface impoundments and in soil/sludge from dried out and/or abandoned surface impoundments (so that chemical concentrations in nearby wetlands can be predicted, or concentrations in soils associated with overtopping events can be predicted).
- b) The empirical study of the resuspension and subsequent dry deposition of particles from surface impoundments.
- c) The volatilization and subsequent near-field dispersion of SVOCs and VOCs from water bodies.
- d) The study of uptake of chemicals from sludge/soil from surface impoundments, including SVOCs and VOCs from air by plants and SVOCs and VOCs from contaminated soil by plants. See BJC (1998) for a compilation of data (and regressions) on plant uptake of 8 inorganic chemicals from various contaminated soils.
- e) The study of toxicity of chemicals from sludge/soil from surface impoundments to ecological receptors. (It is apparent that toxicity data and exposure factors were only available for 35 of 256 chemicals, p. C-179).
- f) The study of the interactions of chemicals in determining bioaccumulation and toxicity of chemicals from surface impoundments.
- g) The evaluation of 3MRA (originally intended for use in this study, p. C-2) or another multimedia model for use in assessing risks from surface impoundments.
- h) The further development of scaling factors for interspecies extrapolation. See Sample and Arenal (1999) for recent factors.
- i) The study of methods to discourage biota from colonizing surface impoundments.

j) The assessment of potential magnitude of residual risk of chemicals not selected for assessment

k) A study of sensitivity of the risk and hazard measures to alternative assumptions regarding hazard and potency

l) A study of sensitivity of the risk to presumptions regarding biophysical and photochemical conversions

[prioritization of these areas requires discussion by all subcommittee members at the Oct meeting]

Sensitivity analysis may be used as an effective means to focus limited resources on studies which address those areas of uncertainty that have the largest impact on screening-level risk results.

3.3.2.2 Question 3 b: Based on the screening-level estimates we developed for other indirect and ecological risks, did it appear that we overlooked potential problem areas?

In general, potential problem areas (e.g., problematic pathways) were not overlooked; however, the terminology related to potential levels of risk is confusing, such that potential risks may have been overlooked in the conclusions.

In evaluating the screening-level estimates for indirect risks, an exploration of the impact of chemical selection and presumptions of hazard and potency for certain chemicals is needed.

In general, potential problem areas related to ecological risk assessment were not overlooked. It would be useful to have more justification for the presumed negligible exposure of ecological receptors to air pollutants. If a more refined ecological risk assessment is performed, some consideration of the chronic exposure implications of overtopping events, flooding, dike failure, liner failure, etc. would be helpful. EPA states that the agency overlooked threatened and endangered species (p. C-160), but that is not really true. Given the conservative character of the screening ecological risk assessment, it should apply equally to most threatened and endangered and non-threatened individuals, unless there is reason to believe that these organisms are more sensitive than others. The only exception may be the amphibian and reptile populations for which reproductive data were not available.

The subcommittee is uncomfortable with the approach used to categorize facilities where indirect pathways are a potential concern. The use of simple ranking categories to produce three equal-sized bins for some pathways may underestimate (or overestimate) the actual risk. (For example a designation of level 1 for Surface Area may still pose significant risk.) Therefore, the final ranking heading "Potential Concern" suggests more certainty than warranted. A better heading may be "Greatest Concern" or "Highest Potential Concern." (See further discussion of terminology in part c of this question.)

3.3.2.3 Question 3 c: Did we clearly describe and properly characterize the other indirect human health and ecological risk analyses?

The degree to which biophysical and photochemical transformations were considered and addressed is not clear. It is assumed they were not. For example, from the table of health parameters in Appendix C, it appears that the biotransformation of mercury to methyl mercury was not explicitly addressed in the risk assessment.

Several additional points of clarification would be helpful.

- a) Only chemicals that bioaccumulate were considered for IEP. How was it determined if a chemical can bioaccumulate (p. C-135)?
- b) Volatilization was considered only for the chemicals that "have the potential to volatilize." How was this potential determined (p. C-138)? (Vapor pressure greater than some number?) How was a VOC defined? (based on current national air quality regulations?)
- c) Cut-off points for volatilization (< 250 m, 250-500 m, >500 m) and particulate entrainment (>300m, 150-300 m, <150 m) were based on "significant changes" in the modeling results reviewed (p. C-142). This threshold needs better definition.
- d) Tables 3-21 and 3-22 should include a column of "Least Concern" for the sake of completeness.

In general, the methodology for the ecological risk analysis was presented clearly, but results could be clearer, and the definition of terms could be improved in some cases.

The use of the terms "potential concern" and "lower concern" is not very clear. Although they are defined for the ecological risk assessment on p. 3-42 and for the "other indirect pathways" assessment on p. 3-36, their definitions are not intuitive or literal. All

1 facilities with ecological risk exceedances are, in reality, of “potential concern.” Similarly,
2 all facilities with potential for completion of at least one indirect exposure pathway are of
3 “potential concern,” in contrast to the definition on p. 3-36. Perhaps “lower potential
4 concern” and “higher potential concern” would be more appropriate. It is assumed that
5 facilities that had no exceedances were not included in the “lower concern” category, but
6 this is not evident from the definition on p. 3-42. EPA may also consider renaming the
7 “Least Concern” category as “No concern” or “Negligible Concern” for clarity, as the literal
8 meaning of least concern suggests that there may be concern, albeit small.

9 The terms “lower concern” and “potential concern” should be defined in all tables
10 where they are used (e.g., Table 3-2, Table C.1-19), though as stated above, the
11 Subcommittee would prefer different terms. Tables that apply to the human health risk
12 assessment only (e.g., Table 3-6 on the direct inhalation of air) should be labeled as
13 human risk tables. Tables should be self-explanatory.

14 The statement on p. 3-41 “The ecological screening assessment is precautionary
15 because it is based on direct ingestion or uptake of the surface impoundment influent” is
16 somewhat misleading. A similar statement is made on p. C-162. The risk assessment for
17 vertebrates is based on dietary uptake of foods that have accumulated chemicals from the
18 SI, and direct ingestion of sludge/soil and water from the SI. For plants and soil
19 invertebrates, the risk assessment is based on direct contact with the sludge/soil.

20 Terms such as “facility risk,” “surface impoundment risk” and “constituent risk,” that
21 are defined on p. C-177 are not quite clear. For example, we believe that facility risk
22 consists of the sum of hazard quotients of multiple chemicals across one receptor at one
23 facility, but the role of chemical constituents in the definition is not discussed.

24 The conclusion that “these constituents and impoundments do not pose significant
25 risks to . . . the environment” (Sect. 3.6, 2nd para) is not supported by the screening-level
26 ecological risk assessment. Similarly, the conclusion that “Based only on this initial
27 screening level analysis and using precautionary assumptions, no more than 29 percent of
28 facilities nationally may pose potential concerns to ecological receptors that live near, or
29 make direct use of, surface impoundments” (top of p. 3-49) is not supported by the risk
30 assessment if the reader uses the literal definition of “potential.” In fact, these statements
31 conflict with the statement on p. C-47 that “the majority of facilities have some potential for
32 adverse ecological effects.” Facilities with less than 38 receptor exceedances across
33 facilities still have potential for risk, according to this assessment.

34 One point that is not made very clearly is that almost all facilities (92%, Table 3-24)
35 pass through the screening-level risk assessment (which is not consistent with the
36 statement that “29 percent of facilities may have localized ecological impact during their

operation or after closure,” p. ES-6). Only 8% of facilities are eliminated from concern in the screening assessment. This makes the reader think that either 1) SIs have a high potential for ecological risk or 2) exposure or effects assumptions were too conservative to be useful.

The suite of assessment endpoints and the criteria for their selection (p. C-160) was a strength of the assessment. The assessment is clear in describing pathways that were not considered in the ecological risk assessment (dermal and inhalation) and in explaining that risks to populations were inferred from risks to individuals and how risks to plant and invertebrate communities were inferred.

References

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Sample, B. E. and C. A. Arenal. 1999. Allometric models for interspecies extrapolation for wildlife toxicity data. *Bull. Environ. Contam. Toxicol.* 62:653-663.

3.4 Question #4 Survey Data on Chemical Constituent Presence/Quantity

3.4.1 Please comment on the appropriateness of the application of the Agency’s data processing and analysis protocols for ensuring consistency in interpreting survey data on a specific constituent’s presence in an impoundment, or that constituent’s quantity.

3.4.1.1 Background

The Agency used data processing and analysis protocols to ensure consistency in interpreting survey data on a specific constituent’s presence or quantity in an impoundment. Sections A.4.2.1 and A.4.2.2 in Appendix A to the SIS report describe the various processes and protocols employed to interpret non-detect data reported with a detection limit, non-detect data reported without a detection limit, present but quantity unknown (PQU) data and missing sludge data.

3.4.1.2 Assessment & Recommendations

1 Regarding the appropriateness of the Agency's data processing and analytical
2 analysis protocols and presentation techniques as they apply to the use of surrogate data,
3 the Subcommittee found:

- 4 a) The Agency designed a structured data process and structured protocols for
5 dealing with surrogate data that consists of detection limit look-up tables, a
6 decision tree for imputing non-reported quantities and an algorithm for
7 calculating sludge concentrations. As described, this structured approach
8 combined with the quality assurance step of double data-entry are
9 appropriate for the incomplete survey data and will ensure that similar data
10 gaps will be addressed in a consistent manner.
- 11 b) The consistency of outputs from these data processes and protocols and
12 how the Agency interprets survey information to generate the resulting
13 surrogate datum can vary from contaminant to contaminant. For example, the
14 detection limit look-up table for one contaminant lists a method detection
15 limit while a quantitation limit is listed for another contaminant. Furthermore,
16 the outputs from the data processes and protocols vary according to the
17 proximity of a similar impoundment that has reported data. That is the
18 surrogate concentration may be taken from a similar functioning
19 impoundment at the same facility or a different facility with the same 2 digit
20 industry group. Please refer to the following specific charge questions 4.4
21 and 4.7.

22 **3.4.2 Please comment on the appropriateness of the application of the**
23 **Agency's analysis methods and presentation techniques to distinguish and**
24 **explain the various degrees of certainty in the findings.**

25 **3.4.2.1 Background**

26 The SIS report clearly recognizes and discusses the reality of uncertainty when
27 undertaking a nationwide study and when inferring from a limited database consisting of
28 data of varying quality and completeness. EPA also used analysis methods and
29 presentation techniques to help distinguish and explain the various degrees of uncertainty
30 in the findings.

31 **3.4.2.2 Assessment & Recommendations**

32 Regarding the appropriateness of the analysis methods and presentation
33 techniques for uncertainty as they apply to the use of surrogate data, the Subcommittee
34 found:

- 1 a) That the discussions of uncertainty are qualitative and lacking quantitative
2 criteria and ranges of potential uncertainty. Qualitative statements are made
3 about the quality of the modeling results as a function of the quality of the
4 concentration data reported in the survey. For example, on page 3-5 we find
5 "EPA is most confident in those (concentration) data where respondents
6 reported a value above a limit of detection and far less confident in other
7 values, such as values less than detection limits." If concentrations were
8 reported in the survey, then "... EPA considers these data to have a
9 reasonable degree of certainty" (quote from page 3-6). These types of
10 statements are necessary but not sufficient to describe and explain the
11 various degrees of certainty.
- 12 b) Determining the sensitivity of risk estimates to concentration data would
13 assist in evaluating the impact of surrogate data: The sensitivity of risk
14 estimates to various assumed uncertainties in concentration data could be
15 obtained using Monte Carlo simulations. The uncertainty in the
16 concentration data would need to be characterized as carefully selected and
17 realistic probability distributions that are used as input to the simulations.
18 The results of the sensitivity analyses should indicate whether additional
19 work is needed to reduce the uncertainty of survey concentration data in
20 order to achieve suitably certain risk estimates. All of this assumes the
21 required certainty of risk estimates is established, something that was not
22 done for this SIS study.

23 **3.4.3 Please comment on the degree of clarity of the risk results**
24 **presentation, in the situations when surrogate data and detection**
25 **limit data are employed.**

26 **3.4.3.1 Background**

27 The SIS report gives risk results for two cases: 1) when the direct pathway releases
28 and risks are estimated using contaminant concentration values reported in survey forms,
29 and 2) when those release and risk estimates are based on surrogate and detection limit
30 data. This distinction is made repeatedly within the report's executive summary, the body
31 of the report, tables and appendices.

32 **3.4.3.2 Assessment & Recommendations**

33 Regarding the report's degree of clarity in presenting risk results, when surrogate
34 data and detection limit data were employed, the Subcommittee found:

- 1 a) For air, groundwater and surface water pathways the SIS report consistently
2 discriminates between the releases and risks estimated using contaminant
3 concentration values reported in survey forms and those release and risk
4 estimates based on surrogate and detection limit data. Release and risk
5 results are presented separately for surrogate/detection limit waste
6 concentrations. Conducting separate screening risk assessments for
7 reported data and for surrogate/detection limit data is laudable.
- 8 b) The method used to obtain release and risk results when surrogate data and
9 detection limit data were employed was clearly explained.
- 10 c) The clarity of this discrimination between reported and surrogate/detection
11 limit data suffers from mislabeling of tables (e.g., Tables C.1-16 and C.1-
12 17). The related text refers to "groundwater pathway", Table C.1-16 refers to
13 "Groundwater to Surface Water pathway" and Table C.1.17 refers to
14 "Surface Water Pathway".
- 15 d) For ecological risks the SIS report does not but should discriminate between
16 the levels of concern estimated using contaminant concentration values
17 reported in survey forms and those levels of concern risk estimates based
18 on surrogate and detection limit data.
- 19 e) For ecological risk analysis, the SIS report does not but should discriminate
20 between the levels of concern estimated using sludge contaminant
21 concentration values reported in survey forms and those levels of concern
22 risk estimates based on calculated sludge data.

23 **3.4.4 Is it likely that EPA's data imputation protocol, or "surrogate data**
24 **protocol" for imputing waste composition data markedly affected the**
25 **ultimate conclusions regarding potential risks? If so, in what**
26 **direction did the protocol probably bias the conclusions?**

27 **3.4.4.1 Background**

28 The Agency used a structured data imputation protocol when a survey respondent
29 clearly indicated the presence of a particular chemical constituent in an impoundment, but
30 did not indicate a corresponding quantity. EPA used the structured data protocol to impute
31 a surrogate value according to a specific hierarchy of assumptions

1 The theme of the imputation methodology is to find the most similar impoundment
2 possible within the survey database that had data for the chemicals without values. The
3 surrogate data protocol is summarized below.

- 4 a) A nearest neighbor imputation methodology was applied to develop
5 surrogate concentration data where chemicals are expected to be present,
6 but quantities are unknown. In cases where the presence of a chemical in an
7 impoundment could be inferred, a value from a similar impoundment was
8 used to represent a likely concentration. As detailed in the report surrogate
9 concentrations were developed: "(1) where the respondent had checked the
10 "present but quantity unknown" (PQU) flag, (2) where the respondent had
11 entered a chemical but provided no value (and did not check PQU), and (3)
12 where chemicals were reported in wastewater effluent (to infer presence
13 within the impoundment)."

14 The imputation methodology employed a decision framework that was
15 programmed into a data processing system to implement the methodology.
16 The process was designed to find the most similar impoundment possible
17 within the survey database that had data for the chemicals without values.
18 The factors considered in order of importance were impoundment location
19 (same facility or similar facility), aeration or not and function (treatment or
20 non-treatment only).

21 Note that because detection limits were decided to be valid representations
22 of concentrations in the impoundments, the detection limit values derived
23 using the techniques described below were available and used for
24 surrogates.

- 25 b) When the survey data did not include a sludge concentration and there was
26 sludge within the impoundment, the sludge concentration was determined by
27 employing "wastewater partition coefficients (K_{dw}) for metals and a soil
28 organic carbon-water partition coefficient (K_{oc}) for organic constituents,
29 along with total suspended solids (TSS) data pulled from the study survey."
30 This calculation was designed to account for contaminants contained by the
31 suspended solids, since total wastewater concentrations not dissolved
32 wastewater concentrations were reported in the survey data. TSS values
33 were obtained directly from the SI survey database or estimated using other
34 data available for the impoundment. If these were not available a default
35 value was used. The other parameters needed to estimate the partition
36 coefficients were taken from the literature.

3.4.4.2 Assessment & Recommendations

Regarding whether the surrogate data protocol for imputing waste composition biased conclusions regarding risk and the direction of any detected bias, the Subcommittee found:

- a) The surrogate data protocol allows for a risk assessment to be conducted when data inputs are incomplete and provides a consistent procedure for selecting surrogate values.
- b) The use of the surrogate data protocol tends to increase the number of risk exceedance impoundments and appears to have a conservative bias in the perspective of protecting human health, when compared to risk assessments performed solely on survey data. A comparison of the risk analysis results indicates that the total number of facilities that exceed risk criteria or may exceed risk criteria approximately doubles when surrogate/DL concentrations are used in addition to reported concentrations.
- c) The surrogate data protocol does not identify the impact on the estimated risks from using the surrogate concentrations versus the “true” concentrations. This impact might have been estimated if acceptable distributions of “true” concentrations could have been specified based on measurements from the other impoundments that had no non-detect data.
- d) The surrogate data protocol uses best available data, but there are no criteria set up to evaluate if “the best available data” meet the quality of data required for the project. The required quality of the risk estimates was not specified, which makes it difficult to specify the quality of data required. If there was a need to estimate risks within say an uncertainty factor of 10, and if uncertainties on model parameters other than concentrations were established, then one could determine what levels of uncertainty in the concentrations would still permit achieving the factor of 10 criteria. Trial and error and sensitivity analyses might have provided some guidance if the adopted structured approach was sufficient.
- e) It may be useful for the Agency to evaluate information on the range of surrogate data values available for a given constituent at a given impoundment. If the range of values is small, then the uncertainty in specifying a surrogate value is somewhat reduced. If the range were large, then using the maximum surrogate values would be more conservative than

otherwise. Without an evaluation of this range information, the degree of conservativeness in risk assessments that results from using the maximum of those values cannot be assessed.

f) The SIS report does not offer any information as to how the use of the surrogate data protocol biases ecological risks or risks resulting from indirect pathways.

g) The charge question cannot be answered properly without performing a sensitivity analysis. This might be done as follows: Select a subset of facilities with impoundments that did not require surrogate data. Remove the quantitative values to create impoundments that require surrogate data. Apply the imputation methodology to these sites and follow through with the risk assessment process using the surrogate data. Determine whether the conclusions of the risk assessment are changed from those obtained before the original quantitative chemical values were removed. Rather than use actual impoundments, one could also set up a computer study to do this investigation. This simulation study could be set up to mimic as closely as possible the characteristics and types of facilities actually encountered in the survey. The effect on risk assessment conclusions could be determined for various amounts of non-detects and non-quantitative responses on survey forms.

3.4.5 Should EPA have used any other approaches for qualifying or presenting surrogate data?

3.4.5.1 Background

As discussed above, the SIS report discriminates between the direct pathway release and risk estimates based on contaminant concentration values reported in survey forms and those release and risk estimates based on surrogate and detection limit data. This distinction is made repeatedly within the report's executive summary, the body of the report, tables and in its appendices.

3.4.5.2 Assessment & Recommendations

Regarding whether the Agency should have used other approaches for qualifying and presenting surrogate data, the Subcommittee found:

- 1 a) The presentation and qualifying approaches were reasonable, intuitive and
2 readers, who have a range of technical expertise, should understand the
3 source of releases and risk estimates.
- 4 b) It is not an unreasonable approach to attempt to impute a value from a
5 similar impoundment or facility. The maximum of all surrogate data values
6 for a given constituent was used in the survey database for risk assessment
7 (page A-36 and A-37). That approach is obviously different than selecting a
8 random value from the set of surrogate values obtained for the constituent.
9 The selection of a maximum rather than a random value could tend to
10 increase the risk estimate to some degree. If a random rather than a
11 maximum surrogate value was used, then the risk estimate could be either
12 increased or decreased depending on the surrogate value used. It appears
13 that the Agency chose to be conservative and select a maximum surrogate
14 value, which would only tend to increase the risk. But there should be some
15 mechanism for assessing the added uncertainty in risk estimates from using
16 that approach. This might be accomplished by specifying a subjective
17 probability distribution of the maximum surrogate values for use in a Monte
18 Carlo uncertainty analysis of risk. Of course, this distribution would be
19 different than the distribution that would apply to a randomly selected
20 surrogate value. Specifying a distribution for the surrogate values would have
21 permitted an assessment of the effect of surrogate uncertainty on risk
22 uncertainty.
- 23 c) For indirect exposure pathways and for ecological risks the SIS report does
24 not report separately the levels of concern estimated using contaminant
25 concentration values reported in survey forms and those levels of concern
26 based on surrogate and detection limit data.

27 **3.4.6 Was using the assumption that a chemical could be present up to the**
28 **detection limit, when it was reported as being present below a**
29 **detection limit, a reasonable concentration to choose for risk**
30 **screening purposes?**

31 **3.4.6.1 Background**

32 For purposes of release and risk assessments, survey values, reported as below
33 detection limits, were not entered into the database as non-detects but entered at the
34 associated detection level concentration. If a contaminant was reported as non-detect
35 without an associated concentration value, a look-up table was employed to select a
36 concentration.

1 On page 3-4 and 3-5 of the main report, it is explained that many different reporting
2 conventions for detection limits were used. Very low and very high detection limits were
3 reported. The Agency is far less confident in risk assessment results for situations where
4 detection limits are used in place of actual data values. Hence, The Agency presented the
5 risk results separately based on whether concentrations or detection limits and surrogate
6 data were reported in the facility surveys. The Agency states (page 3-6) that risk results
7 based on reported concentrations have greater certainty than risk results when detection
8 limits were substituted for unreported concentrations.

9 Much has been written about the treatment of censored/non-detect data, including
10 guidance offered by the Agency (EPA QA/G-9). Treatment of detection limit data is
11 typically managed by one of two general methods: substitution or statistical methods. For
12 the substitution method, the typical approach is to substitute concentrations of zero,
13 concentrations of half the detection limit or concentrations at the detection limit for non-
14 detect data. The choice of the substituted concentration is a function of objectives and
15 decision error of concerns. The statistical method can be used when there are multiple
16 data points for the population being characterized. For example, censored concentration
17 distributions below a detection limit can be estimated from non-censored data above the
18 detection limit, or statistical parameters such as averages can be adjusted to account for
19 censored portions of the population.

20 **3.4.6.2 Assessment & Recommendations**

21 Regarding the Agency's assumption that a chemical could be present up to the
22 detection limit, when it was reported as being below a detection limit, the Subcommittee
23 found:

- 24 a) It is reasonable to use the detection limit in place of the non-detect reported
25 value for purposes of a screening risk assessment. This conservative
26 approach to screening is also compatible with the approach recommended
27 in the SAB's 1998 report on the SIS. Of course, this approach will tend to
28 bias high the estimates of risk. However, this consequence as indicated in
29 the SAB's 1998 report is acceptable and even desirable for a screening risk
30 assessment.
- 31 b) A member of the public asked in response to a Subcommittee telephone
32 conference call as to whether the assumption that a contaminant could be
33 present at a concentration up to the detection limit is reasonable when the
34 contaminant was not expected to be present at the facility. The
35 Subcommittee's response to this expansion to the charge is that the answer
36 would depend on the certainty with which it is believed that the constituent is

not expected at the facility. Very high certainty would suggest reporting a detection level concentration is not appropriate. Lower certainty regarding the absence of the contaminant would suggest reporting a detection level concentration is appropriate for a screening assessment. The Subcommittee was not charged to address this question, and other than the preceding response is not prepared to address this question on a contaminant by contaminant basis.

3.4.7 Did the EPA-generated default detection limit protocol provide reasonable approximations of likely detection limits encountered in the field by the facilities, when the detection limits were not reported in the laboratory analysis?

3.4.7.1 Background

For purposes of release and risk assessments, survey values, reported as below detection limits, were not entered into the database as non-detects but entered at the associated detection level concentration. If a contaminant was reported as non-detect without an associated concentration value, a look-up table was employed to select a concentration. These lookup tables were based on the wastewater analytical methods for wastewater and SW-846 EPA 8000 series were used for organics in sludge. Detection limits for metals in sludges and for other contaminants in wastewater or sludge that lacked a detection limit, available in a commonly used analytical method, were extracted from the detection limits that existed in the survey database. If an air contaminant was reported as non-detect without an associated concentration value, the detection limit concentration was extracted from a look-up table based on Agency air methods. Detection limits for air contaminants not included in the Agency methods were based on best professional judgment.

All look-up table detection limits were multiplied by a factor of 10 to account for potential interferences.

3.4.7.2 Assessment & Recommendations

Regarding whether the default detection limit protocol provided reasonable approximations of likely detection limits encountered in the field, the Subcommittee found:

- a) EPA should provide further information regarding the "look-up" tables of default detection limits to document whether such look-up values can be assumed to be upper limits on actual concentration values.

- b) The detection-limit look up tables incorporated concentration values that were associated with a variety of detection limit [method detection limits (MDL), instrument detection limit (IDL)] and reporting limits [minimum levels (ML), estimated quantitation limits (EQLs)]. The concentrations associated with these different detection and reporting conventions can be significantly different for the same contaminant (e.g., EQLs concentrations as defined in RCRA guidance can be as much as 10 times higher than the MDL for the same compound and for some methods the difference between the EQLs and IDLs could be even greater). The contaminants (wastewater metals) for which IDLs were employed, did not suffer from a significant discrepancy as compared to MDLs, since the referenced method incorporated IDLs from a dated document based on older and less sensitive instruments and did not account for the concentration factors that are incorporated into some sample preparative steps. The use of reporting limits (ML and EQLs) instead of detection limits resulted in more conservative estimates from the perspective of protection of human health and the environment.
- c) The Agency increased detection limits by a factor of 10 to account for interferences. Commonly an analytical interference can require that the sample be diluted prior to analysis, likewise high concentrations of analytes, that are of concern, can decrease the effectiveness of preparative concentration steps that lower method detection limits. The safety factor of 10 should be sufficient for most wastewaters. The Agency, recognizing the limitation detailed on page 3-4 of the report, should consult the Office of Water and compare look-up detection limits for sludge contaminants to those in the survey database in an attempt to determine if the sludge detection limits are sufficiently conservative.

3.4.8 Do the results that are based on imputed/detection limit data suggest that further analysis is needed?

3.4.8.1 Background – Refer to Section 4.7.1.

3.4.8.2 Assessment & Recommendations

Regarding whether the risk results based on imputed/detection limit data suggest further analysis is needed, the Subcommittee found:

- a) An indication that further analysis is required is when performance criteria set up before conducting the study are not achieved. The Subcommittee is unaware as to whether the Agency developed such performance criteria.

- 1 b) The Agency should attempt to groundtruth look-up detection limit
2 concentrations by comparisons to the field sampling data and detection
3 limits reported in the survey data.
- 4 c) The SAB's 1998 report made a recommendation to "analyze the sensitivity
5 of the model estimates for the high and low ends of the anticipated
6 parameter distributions". The SIS found the release and risk estimates to be
7 sensitive to the combination of surrogate/detection limit substitutions. It
8 would be valuable to determine the sensitivity of the model outputs for the
9 direct pathways due solely to the detection limit substitution protocol. This
10 sensitivity analysis could be as simple as running the model with
11 concentrations of zero and half the detection level concentrations to
12 determine if the release and risk estimates vary significantly from the more
13 conservative substitution of concentrations at the detection limit. Further
14 sensitivity analyses could be performed to determine the effect on screening
15 risk assessment results if the look-up table detection limit values,
16 themselves, are changed to be larger or smaller than actually used.
- 17 d) Since the report did not document the impact of surrogate data/detection
18 limit data versus survey data on ecological and indirect pathway risks, it
19 would be advisable to perform these sensitivity analyses as well as
20 determining the sensitivity to alternative detection limit concentrations as
21 discussed in the previous bullet.

22 **3.5 Question #5 Analysis and implications of field sampling data**

23

24 **3.5.1 What is the SAB's view on EPA's conclusions about the accuracy of** 25 **the reported survey data on chemical constituent** 26 **concentrations/quantities?**

27 **3.5.1.1 Background**

28 The introduction to Appendix E of the SIS report indicates that the Agency
29 conducted field sampling at a subset of 12 authoritatively selected facilities and
30 subsequently analyzed the collected samples "to supplement other data sources, provide
31 "ground-truth" and fill gaps in data obtained via EPA's *Survey of Surface Impoundments*".
32 Appendix E later identifies the original objectives as;

- 33 Objective 1: Determine whether the waste characterization data provided
34 by the facilities in their survey responses and the

1 corresponding sample analysis results from EPA's sampling
2 program are in reasonable agreement and within the range of
3 values expected (i.e., do the EPA data "verify" the survey
4 data).

5 Objective 2: Determine whether the field sampling and analysis program confirms
6 the presence of constituents reported by the facilities and determine
7 the extent to which the field data identify gaps in the industry-supplied
8 data.

9 The QAPP captured an expanded list of objectives in the following decision
10 statements, which are similar to those in DQO Development document (Attachment A to
11 the QAPP):

- 12 a) Determine, using EPA field monitoring data as a "spot-check" and using
13 process knowledge, whether or not facility-supplied data are reasonable and
14 within the range of values expected or whether the data should be
15 questioned and the discrepancy investigated.
- 16 b) Determine whether or not there are gaps in the industry supplied data and
17 whether those gaps should be filled by conducting field sampling and
18 analysis, or by other means (such as requesting additional
19 information/clarification from the facility).
- 20 c) Determine, using actual field monitoring data (both submitted by facilities
21 and generated by EPA), whether or not the multimedia models provide
22 accurate output.

23 The field teams collected samples of impoundment influent and effluent,
24 wastewater from within the impoundment, sludges, leachate and
25 groundwater. According to the QAPP, these samples were collected using
26 judgmental sampling, which relies upon professional judgment to select a
27 sample that represents the target population.

28 The resulting analytical data are discussed in the body of the report as well
29 as in appendices C and E and attachments to appendix E. All Agency
30 collected data were subjected to data validation and if the data were
31 generated under non-compliant analytical conditions, the associated data
32 were qualified.

To evaluate whether the sampling program contaminant concentrations were within reasonable agreement with the survey data, EPA compared its measured values with those reported by the facility using several statistical approaches and concluded that “there is a pattern of agreement between the waste characterization data provided in the surveys and EPA’s sample analysis results for the corresponding impoundments, sample locations and parameters of interest” and that “there is no reason to question the concentration data provided in the facility survey”.

3.5.1.2 Assessment & Recommendations

Regarding the Agency’s conclusions about the accuracy of the reported survey data on chemical constituent concentration/quantities, the Subcommittee found:

- a) The Subcommittee, not knowing the representativeness of collected samples nor the true constituent concentrations in the various media sampled at the 12 facilities, is unable to authoritatively determine the accuracy of the sampling data. However, the Agency’s use of a structured planning process such as the DQO process, and subjecting the sampling data to data validation are significant steps in respectively assuring and documenting the analytical quality of the data.
- b) Since the samples collected by the Agency were not randomly collected, and since the Subcommittee does not know if the judgmentally collected samples are representative of the media present at the 215 facilities that submitted survey data, the Subcommittee is unable to use the sampling data to authoritatively evaluate the accuracy of the survey data. However, since 88% of the 151 contaminant data pairs are within an order of magnitude of each other and since 78% of time, when there is a difference, the difference is not measurably significant or the survey datum is the higher concentration an argument can be made that the survey data, although positively biased compared to the sampling data, is likely suitable for the study’s conservative purpose.
- c) The Agency should attempt to more clearly justify its rationale for its conclusion that “there is no reason to question the concentration data provided in the facility survey” (quote from page 2-10 of main SIS report). The Agency should make an effort to explain its conclusion in a more quantitative manner rather than basing it solely on the argument that the data are acceptable since they are typically higher and thus yielding a more conservative risk estimate. Agency expertise regarding the spatial and

temporal heterogeneity of wastewaters and impoundment wastes, sampling conditions and the accuracy of analytical methods should be employed to further explore the bias and range of values when comparing sampling data to survey data. For example, if the Agency's sampling was performed during times of elevated temperatures, one may expect a negative bias in volatile organic concentrations in waters versus a 3-year averaged survey datum.

d) The Agency is encouraged to use the sampling data to evaluate the surrogate data protocol (i.e., use the look-up tables for ND and use the nearest neighbor imputation to see how the imputed data match that which was measured in the field.) The Agency may have performed this evaluation since Page 3-11 of the report mentions the important QA role of the sampling data when discussing the "EPA Surrogate Data Protocol". If this evaluation has been performed, the outcome should be more clearly presented.

e) Approval, during the DQO process, to employ performance-based methods in lieu of existing methodology, for these sample matrices, unnecessarily placed additional burden on the Agency to review the applicability of any non-routine analytical method that was employed and comparability of the resulting data.

f) DQOs for the field sampling were not consistently presented in the tiered documents (i.e., DQO Development document, QAPP, SAP and Appendix E). In spite of this oversight, the 3 DQOs described in the original DQO Development Document were addressed during the study and in the SIS report.

3.5.2 What is the SAB's view on EPA's conclusion on the potential incomplete reporting of chemical constituents present?

3.5.2.1 Background

Objective 2: Determine whether the field sampling and analysis program confirms the presence of constituents reported by the facilities and determine the extent to which the field data identify gaps in the industry-supplied data.

For the second objective the Agency compared the number of constituents reported by each facility for each sample location, to constituents in the related samples collected by the Agency and counted the number of constituents that were detected in both and those additional constituents detected solely in Agency.

1 The Agency found that field sampling typically confirmed the presence of
2 constituents reported by the facilities. They also found that the field sampling confirmed
3 the presence of a number of additional constituents not reported by the facilities.

4 **3.5.2.2 Assessment & Recommendations**

5 Regarding the Agency's conclusions on the potential incomplete reporting of
6 chemical constituents, the Subcommittee found:

- 7 a) That the Agency is correct in concluding that the facility reporting is
8 incomplete.
- 9 b) Regarding explanations as to why the facilities did not report the presence of
10 certain constituents, the Agency is encouraged to identify and evaluate local,
11 State and Federal requirements for each of the 12 facilities to determine if
12 the facilities were responsible for detecting the unreported constituents at
13 the concentration levels reported at in the field samples.

14 **3.5.3 Would the SAB recommend alternate approaches, in order to obtain** 15 **the best possible information regarding the exact chemical** 16 **constituents present, given the same budget and time constraints?**

17 **3.5.3.1 Background**

18 "Due to funding and other practical constraints (e.g., mobilizing field teams to
19 multiple sites)", the Agency concluded in its DQO Development Document
20 that "the field sampling must be limited in scope". Such budget and time
21 constraints are typical for data collection activities. Such data collection
22 activities are best designed using a structured planning process, such as the
23 Data Quality Objective Process used by the agency, so that an optimized
24 sampling and analytical design will maximize the return on consumed
25 resources and increase the chances of achieving objectives.

26 **5.3.2 Assessment & Recommendations**

27 Regarding the Agency's request for recommendations under the same budget and
28 time constraints, the Subcommittee found:

- 29 a) The Subcommittee is not familiar with the details of the "budget and time
30 constraints" that the Agency had to operate under, therefore it is not possible
31 for the Subcommittee to respond to this question as worded. The

Subcommittee recognizes that the realities of constraints can limit data gathering, decrease information and increase uncertainty in data-based decisions. The Subcommittee believes that the Agency did a responsible job of documenting the constraints and their logic for choosing judgmental sampling, grouping of facilities and single sampling visits.

b) It would have been advantageous if the survey questions could have been structured such that more complete and sufficient information on concentrations was obtained. For example, it would have been helpful if the Agency decreased the flexibility it allowed in the reporting of chemical concentrations and non-detect values.

c) More thought should have been given to how the survey and EPA-measured data would be statistically compared and the requirements of that comparison, such as comparability of the survey and EPA-measured data.

3.5.4 Findings & Recommendations Independent of the Charge

3.5.4.1 Quality Assurance Project Plan (QAPP)

EPA requires that a QAPP must be required for any project that generates new data by or for EPA. A QAPP document was prepared for the field sampling and analysis program conducted to support the SIS (see page 2-9 and 2-10 of the main EPA report and Appendix E and Attachment E-1).

The subcommittee finds that the QAPP was generally well done. It provides a clearly written summary of the objectives of the field sampling effort, the sampling design and its rationale and various QA/QC specifications. The Data Quality Objectives (DQO) process planning effort, which was conducted to support the development of the QAPP, is documented in an appendix to the QAPP. The DQOs specified in the first 4 steps of the DQO process provided in the plan are generally well done, but step 6 ("Specify Limits on Decision Errors) is less satisfactory in that it provides no quantitative basis for determining the number of samples from selected facilities that should be collected. (Indeed, on pages 17 and 18 of the DQO report, the plan called for basing the number of samples for each facility entirely on practical considerations such as budget and schedule, rather than on the quality of the information needed to achieve the purposes of the field sampling program (validating models, completing the risk analyses, and verifying facility-supplied survey data).) The reason given is that the study will not be used directly to test a hypothesis. That rationale may have derived from the emphasis in the EPA DQO guidance document (QA/G-4) published in 1994 on testing hypotheses. However, EPA requires that a

systematic planning process be used for *all* studies, not just those that formally test hypotheses.

3.5.4.2 Appendix E (Field Sampling and Analysis)

In Appendix E, page E-2, we see that the selection of facilities was approximately proportional stratified sampling, i.e., roughly 5 to 10 % of the facilities in each of the various Standard Industrial Classification (SIC) groups (strata) were selected for sampling. Using proportional stratified sampling is a reasonable approach, although the expected variability in data to be obtained and the representativeness of those data for the population of facilities should have been considered in determining the number of facilities. Also in Table E-1 we see that a key consideration in the selection of a facility was whether it was located near another facility. One potential problem with this approach is that facilities in close proximity may yield data and information that are redundant. The Subcommittee has not found any analysis or discussion on the issue of redundancy. Is it possible that redundancies could have occurred because paired facilities were sampled in close proximity in time (both within a given week), perhaps due to similar weather or plant operating conditions? Also, 9 of the 17 major SIC groups had no facilities selected for sampling. There was no discussion in the report on the sensitivity of the conclusions due to not sampling the 9 SIC groups.

Section E.3 of Appendix E is a summary of results. The data were examined for two objectives: (1) Do the EPA data “verify” the survey data? (2) Do the EPA data confirm the presence of constituents reported in the industry-supplied survey data, and do the EPA data identify data gaps in the survey data? As regards to question 1, the data analyses (Figure E-1, E-2, E-3 and E-4) clearly show that the survey data are generally higher than the corresponding (paired) values from the EPA field sampling. However, it is interesting that the conclusions on page 2-9 of the main report tend to emphasize the agreement (within one or two orders of magnitude) in the facility-supplied survey data and the corresponding EPA data rather than their differences. No emphasis is made in the main report that most (64%, actually) of the survey data are greater than the corresponding EPA field data, although that point is clearly stated on page E-12 of Appendix E. Also, on page 2-10 of the main report, EPA states “EPA has concluded that there is no reason to question the concentration data provided in the facility survey.” The Subcommittee is not sure that conclusion is warranted.

The Agency notes that the survey and field data may not be comparable because the survey requested data over a 3-year period, whereas EPA data were collected within a 1-2 day period. It may be reasonable to expect that the EPA-collected data will tend to be more variable than the survey data because of the longer time period for the survey data. Also, presumably the EPA-collected data were obtained on days that followed the 3-year

1 period for the survey. Hence, if impoundment operations changed, the data may not be
2 comparable. It is unfortunate that the survey question did not require information on the
3 variability and range of daily measurements so that the survey and EPA data would be
4 more comparable. On page 2-9 of the main report (near bottom of page) it is stated that
5 the results cannot be statistically extrapolated to the population of facilities because the
6 facilities sampled were not selected randomly. This points out that the original design
7 developed by EPA of using only judgment to select facilities led to problems of
8 interpretation of the data. At least in hindsight, it appears that the random selection of
9 facilities within SIC strata would have been a better design for making inferences to the
10 population of facilities. On the other hand, perhaps the Agency did not have the resources
11 to collect enough random samples to make sufficiently confident inferences to the
12 population. In any case, we are left with data that suggest the survey results may tend to
13 exaggerate the concentrations actually present. If true, that could somewhat inflate the risk
14 estimates. It is not clear to me if this potential bias was taken into account when the
15 Agency assessed the uncertainty of the risk estimates based on survey results.

16 Regarding question 2 above (confirm concentration; gaps in data), on page 2-10 of
17 the main report it is reported that EPA found unreported constituents above a limit of
18 detection. On page 2-11 EPA provides several reasons why this may have happened.
19 But it is unclear to the Subcommittee how EPA took this finding into account in the risk
20 assessments and their interpretation. On page E-17 (bottom) of Appendix E it is stated
21 that quantitation of this information provides supplemental data for possible use in the
22 uncertainty analysis of the study, but it is not clear if this was actually done.

23 3.5.4.3 Uncertainty Issues

24 [Since some of these findings may be applicable to other charge questions, they should
25 be shared with our fellow groups]

26 The DQO plan, as well as the QAPP, talks in terms of using the sample data
27 generated from the field sampling program to obtain risk estimates “with an acceptable
28 degree of certainty” (page 15 of the DQO appendix to the QAPP document). But the
29 Subcommittee has not found anywhere in the documentation for the SIS project what the
30 acceptable degree of certainty might be. Apparently, EPA is satisfied with the degree of
31 certainty *achieved* for the risk estimates without quantifying this acceptable level of
32 certainty.

33 The Executive Summary of the main report does not discuss the uncertainty in the
34 results. This lack of discussion leaves the reader with no clue about the confidence in the
35 results. Also, in Chapter 2 (Characterization of Industrial Surface Impoundments), most of
36 the tables and figures of results provide no information on the uncertainty or variability in

1 the presented numbers. In the Subcommittee's view, it is not adequate to simply refer the
2 reader to an appendix where that information can be found. An example of a highly
3 uncertain result is the estimate of total quantity of wastewaters managed (Table 2-1, page
4 2-3 of main report). For the Total Population of Direct Dischargers and Zero Dischargers,
5 the estimated amount is 654,468,645 metric tons. But in Appendix B we find that the 95%
6 confidence interval is -15,179,569 tons to 1,324,116,859 tons. Hence, the amount
7 reported in Table 2-1 is highly uncertain, but the reader does not know it unless he/she
8 goes to the appendix. Also, the data in Table 2-1 and some of the other tables have too
9 many significant digits. The results should be rounded to perhaps 3 significant digits, e.g.,
10 654,000,000 tons instead of 654,468,645 tons. Another example where quantitative
11 uncertainties should be provided is Table 2-12. That table provides estimates of the
12 number of people living within a given distance of an impoundment, as well as other
13 important information needed for risk assessment

14 In Chapter 3 (Human and Ecological Risk Analysis) of the main report, the
15 discussion on uncertainty of results in Section 3.1.2 (Overview of Results) is very general
16 and non-quantitative. For example on page 3-5 and 3-6 the report states that risk results
17 based on survey data reported as less than the detection limit have a greater level of
18 uncertainty than risk results based on survey data reported as real quantitative numbers. In
19 the Subcommittee's view, such qualitative statements, while helpful, leave the reader with
20 no metric for judging quality of the results.

21 Chapter 3 presents discussions of uncertainties associated with groundwater
22 analysis, inhalation, surface water and other indirect pathways. These discussions are
23 important and necessary, but they are all nonquantitative. The reader is referred to
24 Appendix C for further information on uncertainties and the Monte Carlo simulations
25 conducted for the groundwater pathway. The discussion in Appendix C and Attachments
26 C-10, C-11 and C-12 seem quite thorough and includes considerable detail on how the
27 Monte Carlo simulations were conducted. However, some of the terms used to describe
28 the Monte Carlo results in Attachment C-11 are not well defined, which makes it difficult to
29 interpret the results. For example, the Subcommittee could not find in Appendix C the
30 meaning of "The *extreme* 10th percentile DAF..." or the "*range* for 10th percentile peak
31 DAFs." Their words have very specific meanings depending on how the Monte Carlo
32 analyses were conducted.

33 The report of the SAB review of the Surface Impoundments Study plan (EPA-SAB-
34 EEC-98-009, published in August 1998)) contains section 3.1.5.4 (Modeling and
35 Sensitivity Analysis Issues). The first paragraph of that section notes that models are more
36 sensitive to some parameters than others. The subcommittee recommended that the
37 Project Team analyze the sensitivity of the high and low ends of the model estimates
38 obtained from probabilistic risk analyses to rank the model parameters by sensitivity. The

rationale for this recommendation was that EPA could then focus on the highly sensitive, highly uncertain parameters. It is not clear from the discussion of the Monte Carlo analyses in Appendix C whether or not sensitivity analyses was conducted using the Monte Carlo risk estimates. If not, the Agency may want to conduct such analyses to further evaluate which parameters are most responsible for the variability or uncertainty in the simulated risk estimates.

In Section 3.1.5.5 of the SAB review report referenced above, the SAB recommended that the Agency describe, in simple and understandable terms, the uncertainty associated with risk assessments taken beyond a conservative deterministic screen. The Agency could have done more in that regard. Indeed, while various distributions of quantities were obtained using Monte Carlo analyses, the distributions were presented without any summary statements. The SAB noted that the form of the summary statement should depend on the assessment endpoint selected. For example, if the endpoint is a frequency distribution of individual risks (i.e., for individual persons) in an exposed population, the assessment should disclose the uncertainty about the “best estimate” of this frequency distribution. This uncertainty would be expressed as a 90% to 95% credibility interval for individual risk about each quartile of the frequency distribution. If the assessment endpoint is an average individual, the assessment should include a best estimate of the average and a credibility interval about that best estimate. Based on Attachment C-11, it appears that the Agency has the information needed to make such uncertainty statements. The Agency should consider improving their interpretation of the Monte Carlo results and include some summary statements in the Executive Summary.

3.6. Question #6: Groundwater Source Term

3.6.1 Background

In the Surface Impoundment Study, EPA evaluated the risk to human health posed by chemical constituents migrating from surface impoundments via the groundwater pathway. A groundwater solute fate and transport model – the EPA Composite Model for Leachate Migration with Transformation Products (EPACMTP) – was used for this purpose. The EPACMTP model considers transport in both the vadose and saturated zone. Fate and transport processes included in the model are advection, hydrodynamic dispersion, equilibrium sorption, and rate-limited chemical hydrolysis. Human health impacts from ingestion of contaminated groundwater and surface water, and from ingestion of fish from contaminated surface waters, were considered in the risk assessments conducted. Exposure scenarios considered in the risk modeling were ingestion of water from a well downgradient of a leaking surface impoundment, ingestion of surface water that receives impoundment-contaminated groundwater, and ingestion of fish residing in the contaminated surface water.

1 The mass rate of release of chemical constituents in liquid from the surface
2 impoundment into the subsurface constitutes the source term for the groundwater solute
3 fate and transport model. The properties that define the source term for a particular
4 chemical constituent or group of constituents are: (1) surface area of the impoundment; (2)
5 leachate flux from the impoundment, i.e., flow of water leaking out of the bottom and sides
6 of the impoundment per unit of impoundment surface area; (3) concentration of constituent
7 or group of constituents in the leachate; and (4) duration of the leachate infiltration. Charge
8 #6 is focused on item (3), the concentration of chemical constituents in the leachate.

9 Concentrations of chemical constituents in leachate were requested by EPA in the
10 national survey of surface impoundments. Relatively few facilities in the survey sample
11 reported leachate data, however, implying that there is little monitoring of the presence and
12 abundance of chemical constituents in the groundwater beneath and near to surface
13 impoundments. While leachate data reported were sparse, virtually all facilities that
14 provided any data on impoundment liquid constituents gave data for impoundment
15 wastewater composition.

16 In performing the risk modeling for the groundwater pathway, EPA desired to use a
17 consistent approach for the groundwater source term for the various sites and scenarios
18 considered. The original intent was to use leachate data for the groundwater source term.
19 The limited data on leachate composition, however, forced EPA to reconsider this
20 approach. EPA decided to use impoundment wastewater composition data instead of
21 leachate data.

22 The core issue relevant to Charge 6 is the use by EPA of wastewater composition
23 as the source area water composition for the groundwater exposure/risk modeling. EPA
24 contends that wastewater composition will reasonably approximate leachate composition
25 for impoundments in which little or no sludge is present. EPA has some concern, however,
26 that in impoundments in which some amount of sludge is present, the concentrations of
27 some constituents could be considerably different in the pore water of the sludge than in
28 the impoundment wastewater. EPA's review of some field data on sludges, compared to
29 the corresponding wastewater composition, indicated to the Agency that the decision to
30 use wastewater concentration may have underestimated the contaminant mass for some
31 chemical constituents.

32 **3.6.2 EPA poses two questions under Charge 6:**

33 **(a) Would the SAB recommend another approach for representing the**
34 **groundwater source term, for example, performing a bounding analysis, using the**
35 **sludge data, where available, to represent an upper bound of the groundwater**

1 **source term, and using wastewater data as the lower bound, for those chemical**
2 **constituents for which this situation may be an issue?**

3 **(b) Compared to other sources of uncertainty in the groundwater and**
4 **groundwater to surface water pathway analyses, how large a source of**
5 **uncertainty does the decision to use wastewater composition data appear to**
6 **introduce into the overall study conclusions?**

7 **3.6.2.1 Weaknesses and strengths of the EPA approach**

8 The weakness of the EPA approach to defining the groundwater source term -
9 using the impoundment wastewater composition to represent the composition of leachate
10 leaking from the impoundment - is that the concentrations of some constituents entering
11 the groundwater may be significantly different from the concentrations in the impoundment
12 wastewater. These differences may arise due to reactions in the sludge on the bottom of
13 the impoundment, or to reactions that occur in the course of transport through the
14 impoundment liner or barrier material. Moreover, the nature of such reactions may change
15 over time, as changes in wastewater and sludge composition may lead to changes in the
16 type and solubility of sludge constituents. Since the source area concentration directly
17 influences the calculated exposure concentration of a constituent at receptor locations, it
18 clearly would be best to use leachate data rather than an approximation of leachate data.

19 Defining the groundwater source term as the impoundment wastewater
20 composition is reasonable in a number of respects, however. It enables consistency in the
21 risk modeling across all the locations in the survey sample. The wastewater compositions
22 will only approximate the impoundment leachate concentrations, but the related uncertainty
23 is likely not greater than the uncertainty that would be involved with estimating the
24 modification of impoundment wastewater constituent concentrations as a result of
25 movement through the sludge, liner, and barrier material. In addition, the EPA approach is
26 not uniformly nonconservative. That is to say, the concentrations of some constituents will
27 be overestimated by considering the impoundment wastewater as representative of the
28 leachate. It will not be the case that concentrations of all constituents are underestimated.
29 For example, the wastewater composition data used appear to be total analysis data,
30 reflecting analyte present in suspended solids as well as in the aqueous phase. The TSS
31 fraction may not be transportable through the unsaturated and saturated zones. In addition,
32 some of the surface impoundment analytes of concern, identified in the facility survey, tend
33 to sorb strongly to earthen materials, and would be unlikely to migrate far past an earth
34 material liner. Benzo(a)pyrene and benzo(a)anthracene, listed in Table 3-15, are
35 examples. Fluoride and arsenic, two primary analytes of concern (Tables 3-8 and 3-15),
36 can also sorb strongly to earthen materials such as oxide minerals under some chemical
37 conditions, though they also can be completely dissolved under other conditions.

3.6.2.2 Assessment and recommendations

The use of impoundment wastewater composition to represent impoundment leachate composition is a reasonable approach given the very limited submittal of leachate data by survey respondents. While reactions in the sludge layers, liners, and barrier materials of impoundments will modify concentrations of some constituents, estimating these modifications for a large number of sites would yield results with substantial uncertainty. Significant data collection would be needed to reduce this uncertainty, and if additional data collection was to be undertaken, it would make most sense to put resources into acquiring more leachate quality data, which are directly relevant. It would be very difficult to work in a rationale, defensible manner from sludge data alone. There would be issues of the representativeness of the data, considering that only small quantities of sludge are employed in any single sludge analysis, and also a range of issues related to selection of an appropriate partitioning model. Moreover, Even if more accurate source area constituent concentrations were obtained from a leachate data collection effort, the major conclusions of the risk modeling analysis with respect to the groundwater pathway would remain the same. Consider, for example, the major conclusion presented on page 3-16 of the report: "the highest risks for the groundwater pathway on an impoundment basis correlate strongly with the absence of a liner." This conclusion would not change if the source area constituent concentrations were higher or lower. Moreover, the EPA risk analysis indicated that "very few facilities- less than 1 percent" exceeded risk criteria for analytes of concern in groundwater, considering both direct consumption of groundwater as well as indirect human exposure through surface water impacted by groundwater (pages 3-15 and 3-28). This indicates that it would be hard to justify a new leachate data collection effort in an attempt to refine estimates of low risk. The subcommittee recommends no change in the EPA approach to defining the source area constituent concentrations for the groundwater pathway risk modeling.

3.6.2.3 Responses to Charge Questions

(a) The SAB supports the EPA approach for defining the groundwater source term, and does not recommend a bounding analysis using available sludge data. The available sludge data are inadequate in the scope of constituents and conditions represented. It may be useful to demonstrate systematically that the main conclusions from the groundwater pathway risk analysis would not be changed if source area constituent concentrations were higher or lower, say by an order of magnitude in each case. If the EPA desires a bounding analysis, it would be more reasonable simply to introduce a concentration factor (say a factor of 10) to estimate (increased) source area constituent concentrations from wastewater composition data.

1 (b) The main conclusions from the quantitative risk estimation for the groundwater
2 pathway (Section 3.2.3.1) and groundwater-to-surface water pathway (Section 3.3.2.1)
3 were as follows: (i) very few facilities exceeded acceptable risk criteria with respect to
4 groundwater and surface water ingestion, and ingestion of aquatic organisms from
5 affected surface waters; (ii) a significant portion of “zero discharge” facilities exceeded
6 risk criteria for the groundwater-to-surface water pathway; and (iii) the highest risks for the
7 groundwater and groundwater-to-surface water pathways were for impoundments without
8 liners. Quantification and consideration of the uncertainty in the source area constituent
9 concentrations likely would not change these conclusions significantly. The numbers of
10 sites that serve as the basis for these conclusions would change somewhat, but the overall
11 conclusions would remain the same. Given the uncertainty in other risk model
12 components, e.g., the magnitude of leakage from the impoundments, the simplified
13 hydrogeological conditions assumed for the groundwater transport modeling, and the
14 simplified exposure scenarios, the uncertainty in the source area constituent
15 concentrations is not unacceptably large.

1

APPENDIX A

2

ROSTERS AND BIOS FOR THE SUBCOMMITTEE

3

FY 2002 EC Roster, to be added

4

FY 2002 EEC Roster, to be added

5

FY2001-02 SIS Roster

6

Bios for the SIS

U.S. Environmental Protection Agency
Science Advisory Board
Environmental Engineering Committee
Surface Impoundments Study Subcommittee*
(edited by KWC)

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a. SAB Members: Experts appointed by the Administrator to serve on one of the SAB Standing Committees.

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- 1 d. Federal Experts: The SAB charter precludes Federal employees from being Members of the
- 2 Board. "Federal Experts" are federal employees who have technical knowledge and expertise relevant
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29 sewage sludge in forests and arid ecosystems. She has developed an ecological risk
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12 design and analysis methods, developing statistical designs for the detection of
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15 right number and location of environmental samples. Dr. Gilbert has also managed and
16 conducted Monte Carlo uncertainty and sensitivity analyses of environmental models, with
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38 briefing on the persistent organic chemicals negotiations. He has published extensively on
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37 **Dr. Michael C. Kavanaugh** is Vice President and the National Science and Technology
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